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## ABSTRACTS

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## ABBREVIATED TITLES USED IN THE ABSTRACTS

| *Abbreviated Title.* | *Journal.* |
|---|---|
| *A.S.T.M. Bull.* | Bulletin of the American Society for Testing Materials. |
| *Aeroplane* | Aeroplane. |
| *Airc. Engng* | Aircraft Engineering. |
| *Airc. Prod. Analyst.* | Aircraft Production Analyst. |
| *Ann. Min. Belg.* | Annales des Mines de Belgique. |
| *Ann. Min. Roumanie* | Annales des Mines de Roumanie. |
| *Ann. Off. Combust. liq.* | Annales de l'Office National des Combustibles Liquides. |
| *Amer. Dyestuffs Rept.* | American Dyestuffs Reporter. |
| *Asph. u. Teer* | Asphalt und Teer. |
| *Auto Engr.* | Automobile Engineer |
| *Auto. Tech. Z. (Berlin)* | Automobiltechnische Zeitschrift (Berlin). |
| *B.P.* | British Patent. |
| *Azerb. neft. Khoz.* | Azerbaidzhanskoe Neftyanoe Khozyaistvo. |
| *Beitr. angew. Geophys.* | Beitrage angewandte Geophysik. |
| *Beitr. Geophys.* | Beitrage zur Geophysik. |
| *Bitumen* | Bitumen. |
| *Bol. Geol. y Min. (Caracas)* | Boletin de Geologia y Mineria (Caracas). |
| *Bol. Inform. Petroleras (B.A.)* | Boletin de Informaciones Petroleras (Buenos Aires). |
| *Boll. Soc. geol. ital.* | Bolletin de la Societa Geologica Italiana. |
| *Brit. Plastics* | British Plastics. |
| *Bull. Acad. Sci. (U.S.S.R. Inst. Seismol.)* | Bulletin of the Academy of Sciences (U.S.S.R. Institute of Seismology). |
| *Bull. Amer. Ass. Petrol. Geol.* | Bulletin of the American Association of Petroleum Geologists. |
| *Bull. Amer. geol. Soc.* | Bulletin of the American Geological Society. |
| *Bull. Ass. franç. Tech. Pétrol.* | Bulletin de l'Association Français des Techniciens du Pétrole. |
| *Bull. Inst. Min. (metall.) Engrs.* | Bulletin of the American Institute of Mining and Metallurgical Engineers. |
| *Bull. Math. Phys. Éc. polyt. Bucharest* | Bulletin de Mathematique et de Physique, Bucharest (École-polytechnique). |
| *Bull. roum. geol. Soc.* | Bulletin of the Roumanian Geological Society. |
| *Bull. S. Amer. Inst. Pet.* | Boletin del Instituto Sudamericano del Petroleo. |
| *Bull. seismol. Soc. Amer.* | Bulletin of the Seismological Society of America. |
| *Bull. Univ. Texas (Bur. econ. Geol. Techn.)* | Bulletin of the University of Texas (Bureau of Economic Geology and Technology). |
| *Bur. Stand. J. Res., Wash.* | United States Bureau of Standards Journal of Research, Washington. |
| *Calif. Oil World* | California Oil World. |
| *Canad. J. Res.* | Canadian Journal of Research. |
| *Canad. Min. J.* | Canadian Mining Journal. |
| *Canad. Min. metall. Bull.* | Bulletin of the Canadian Institute of Mining and Metallurgy. |
| *Chem. & Ind.* | Chemistry and Industry. |
| *Chem. Ind.* | Chemical Industries. |
| *Chem. Met. Engng.* | Chemical and Metallurgical Engineering. |
| *Chem. Rev.* | Chemical Reviews. |
| *Chem. Tr. J.* | Chemical Trade Journal. |
| *Chem. Wkbld.* | Chemische Weekblad. |
| *Chim. e Industria* | La Chimica e l'Industria. |
| *Chim. et Ind.* | Chimie et Industrie. |
| *C.R. Acad. Sci. (Paris)* | Comptes Rendus hebdomadaires des Seances de l'Academie des Sciences (Paris). |
| *C.R. Geol. Pétr. (Strasbourg)* | Compte-Rendu des Seances du Groupe des Geologues Pétroliers de Strasbourg. |
| *Diesel Eng. Us. Ass.* | Diesel Engine Users Association. |
| *Diesel Pwr. Diesel Transportation* | Diesel Power and Diesel Transportation. |
| *Direccion Minas y Geol.* | Publication of Direccion Minas y Geologicas (Argentine). |
| *Econ. Geol.* | Economic Geology. |
| *Engineer* | Engineer. |
| *Engineering* | Engineering. |

| *Abbreviated Title.* | *Journal.* |
|---|---|
| *Flight* | Flight. |
| *Fuel* | Fuel in Science and Practice. |
| *Fuel Oil & Oil Heat* | Fuel Oil and Oil Heat. |
| *Gas Oil Pwr.* | Gas and Oil Power. |
| *Geol. Mag. (Lond.)* | Geological Magazine (London). |
| *Geophys.* | Geophysics. |
| *Glückauf* | Glückauf. |
| *Groz. Neft.* | Groznenskii Neftyanik. |
| *India Rubber World* | India Rubber World. |
| *Industr. Chem.* | Industrial Chemist. |
| *Industr. Engng Chem.* | Industrial and Engineering Chemistry. |
| *Industr. Engng Chem. Anal.* | Industrial and Engineering Chemistry, Analytical Edition. |
| *Industr. Pwr & Fuel Econ.* | Industrial Power and The Fuel Economist. |
| *Ingenieur* | De Ingenieur. |
| *Instruments* | Instruments. |
| *J. Aero. Sci.* | Journal of Aeronautical Sciences. |
| *J. Amer. chem. Soc.* | Journal of the American Chemical Society. |
| *J. appl. Chem. (U.S.S.R.)* | Journal of Applied Chemistry, U.S.S.R. |
| *J. appl. Mech.* | Journal of Applied Mechanics. |
| *J. appl. Phys.* | Journal of Applied Physics. |
| *J. chem., metall. min. Soc. S. Africa* | Journal of the Chemical, Metallurgical and Mining Society of South Africa. |
| *J. Chem. Phys.* | Journal of Chemical Physics. |
| *J. chem. Soc.* | Journal of the Chemical Society. |
| *J. Econ. Ent.* | Journal of Economic Entomology. |
| *J. Geol.* | Journal of Geology. |
| *J. Inst. Fuel* | Journal of the Institute of Fuel. |
| *J. Instn. auto. Engrs* | Journal of the Institution of Automobile Engineers. |
| *J. Inst. Metals* | Journal of the Institute of Metals. |
| *J. Inst. Petrol.* | Journal of the Institute of Petroleum. |
| *J. Oil Col. Chem. Assoc.* | Journal of the Oil & Colour Chemists. |
| *J. org. Chem.* | Journal of Organic Chemistry. |
| *J. phys. Chem.* | Journal of Physical Chemistry. |
| *J. R. aero. Soc.* | Journal of the Royal Aeronautical Society. |
| *J. Roy. Soc. Arts* | Journal of the Royal Society of Arts. |
| *J. Soc. aut. Engrs* | Journal of the Society of Automotive Engineers. |
| *J. Soc. chem. Ind.* | Journal of the Society of Chemical Industry. |
| *J. Soc. Dyers Colourists* | Journal of the Society of Dyers and Colourists. |
| *Khim. Tverd. Topliva* | Khimiya Tverdovo Topliva. |
| *Matières grasses* | Matières Grasses. |
| *Min. & Metall.* | Mining and Metallurgy. |
| *Min. Mag. (Lond.)* | Mining Magazine (London). |
| *Mod. Plastics* | Modern Plastics. |
| *Monit. Petr. roum.* | Moniteur du Pétrole Roumain. |
| *Montan. Rdsch.* | Montanistische Rundschau. |
| *Motor Ship* | Motor Ship. |
| *N.G.A.A.* | Natural Gasoline Association of America. |
| *Nat. Petrol. News* | National Petroleum News. |
| *Nat. Petrol. News, Tech. Sect.* | National Petroleum News, Technical Section. |
| *Nature* | Nature. |
| *Neft. Khoz.* | Neftyanoe Khozyaistvo. |
| *Nickel Ind.* | Nickel Industry. |
| *Nov. Neft.* | Novosti Neftepererabotki. |
| *Nov. Tekhn. Bur.* | Novosti Tekhniki Bureniya. |
| *Nov. Tekhn. Neft.* | Novosti Tekhniki Neftedobvicki. |
| *Oel u.Kohle* | Oel und Kohle vereinigt mit Erdoel und Teer. |
| *Oil Engine* | Oil Engine. |
| *Oil Gas J.* | Oil and Gas Journal. |
| *Oil Wkly* | Oil Weekly. |
| *Ole, Fette, Wachse* | Ole, Fette, Wachse, Seife, Kosmetik. |
| *Olii min.* | Olii Minerali. |
| *Paint Mnfr.* | Paint Manufacture. |
| *Paint Technol.* | Paint Technology. |
| *Petroleum* | Petroleum. |
| *Petrol. Engr* | Petroluem Engineer. |

| *Abreviated Title.* | *Journal.* |
|---|---|
| *Petrol. Press Service* | Petroleum Press Service. |
| *Petrol Tech. (A.I.M.M.E.)* | Petroleum Technology (American Institute of Mining and Metallurgical Engineers). |
| *Petrol. Times* | Petroleum Times. |
| *Petrol. World* | Petroleum World. |
| *Phil. Mag.* | Philosophical Magazine. |
| *Physics* | Physics. |
| *Pipe Line News* | Pipe Line News. |
| *Proc. Amer. Petrol. Inst.* | Proceedings of the American Petroleum Institute. |
| *Proc. Amer. Soc. Test. Mater.* | Proceedings of the American Society for Testing Materials. |
| *Proc. Ass. Asph. Pav. Technol.* | Proceedings of the Association of Asphalt Paving Technologists. |
| *Proc. Instn mech. Engrs* | Proceedings of the Institution of Mechanical Engineers. |
| *Proc. phys. Soc. (Lond.)* | Proceedings of the Physical Society (London). |
| *Proc. roy. Soc.* | Proceedings of the Royal Society. |
| *Producers' Monthly* | Producers' Monthly. |
| *Przeg. Chem.* | Przeglad Chemiczny. |
| *Przem. Naft.* | Przemysl Naftowy. |
| *Public Roads* | Public Roads. |
| *Quart. J. geol. Soc. Lond.* | Quarterly Journal of the Geological Society of London. |
| *Rds & Rd Constr.* | Roads and Road Construction. |
| *Rds and Streets* | Roads and Streets. |
| *Rec. Trav. chim. Pays-Bas* | Receuil des Travaux Chimiques des Pays-Bas. |
| *Refiner* | Petroleum Refiner. |
| *Rev. Comb. liq.* | Revue des Combustibles Liquides. |
| *Rev. Mod. Phys.* | Review of Modern Physics. |
| *Rev. sci. Instrum.* | Review of Scientific Instruments. |
| *Riv. ital. Petrol.* | La Rivista Italiana del Petroleo. |
| *S. Afr. Min. (Engng) J.* | South African Mining and Engineering Journal. |
| *Soap* | Soap. |
| *Strade* | Strade. |
| *Sulz. tech. Rev.* | Sulzer Technical Review. |
| *Summ. Ops, Calif. Oil Flds* | Summary of Operations, Californian Oil Fields. |
| *Tech. Phys. U.S.S.R.* | Technical Physics of the U.S.S.R. |
| *Tekn. Tidskr.* | Teknisk Tidskrift. |
| *Terr. Magn.* | Terrestiral Magnetism. |
| *Times Trade & Engr.* | Times Trade & Engineering Supplement. |
| *Trans. Amer. Inst. Min. & Metall.* | Transactions of the American Institute of Mining and Metallurgy. |
| *Trans. Amer. geophys. Un.* | Transactions of the American Geophysical Union. |
| *Trans. Amer. Inst. chem. Eng.* | Transactions of the American Institute of Chemical Engineers. |
| *Trans. Amer. Soc. mech. Engr.* | Transactions of the American Society of Mechanical Engineers. |
| *Trans. Faraday Soc.* | Transactions of the Faraday Society. |
| *Trans. Inst. mar. Engrs* | Transactions of the Institute of Marine Engineers. |
| *Trans. Instn min. Engrs* | Transactions of the Institution of Mining Engineers. |
| *U.S. Bur. Mines, Inf. Circ.* | United States Bureau of Mines, Information Circular. |
| *U.S. Bur. Mines, Rep. Invest.* | United States Bureau of Mines, Report of Investigations. |
| *U.S. Bur. Mines, Tech. Paper* | United States Bureau of Mines, Technical Paper. |
| *U.S. Geol. Surv. Bull.* | United States Geological Survey Bulletin. |
| *U.S.P.* | United States Patent. |
| *World Petrol.* | World Petroleum. |
| *Z. dtsch. geol. Ges.* | Zeitschrift der Deutschen Geologischen Gesellschaft. |
| *Z. Geophys.* | Zeitschrift für Geophysik. |
| *Z. prakt. Geol.* | Zeitschrift zur Praktische Geologie. |
| *Z. ver. dtsch. Chem.* | Zeitschrift Vereins deutscher Chemiker. |

**(Certain periodicals listed above have not been available during 1946.)**

# ABSTRACTS.


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## OILFIELD EXPLORATION AND EXPLOITATION.

### Geology.

**1. Theory of Diastrophic Movement.** R. C. Tuttle. *Oil Wkly*, 3.9.45, **119** (1), 42.—The earth is an oblate spheroid. If the polar diameter were increased by only 4 ml, this would put the poles 2 ml in the air, giving an accumulation of ice and snow. There would then be a large land area high enough above sea-level and in the frigid zone for glaciation to start.

When a wax-coated rubber sphere was compressed slightly along its axis of rotation the wax coating developed cracks running N.W.–S.E. and N.E.–S.W. The earth shows folds and faults along similar lines. While the sphere was in this oblate condition it was again coated with wax, and thicker coats built up in areas corresponding with the continents. While rotating it was allowed to return to its normal form, and the central parts of the continental masses collapsed and buckled, while their edges curled away from the ball, and the parts corresponding with the ocean beds buckled upwards. Both the collapsing and bulging were elongated in poleward directions. The raising of the continental platforms above sea-level would lead to erosion of stream channels or to canyons through them (cf. submarine canyons). The Atlantic shows a general north–south central ridge.

The earth's centrifugal and centripetal forces are essentially balanced, but this balance might be upset if the tidal influences of the sun and moon were in phase, and if this were combined with the near approach of a star. This might cause the earth to become oblate, leading to enormous equatorial tides which would brake the earth. Together with other factors this might allow a return to sphericity, causing a fall in sea-level in the equatorial regions, spreading waters into newly formed epi-continental seas, and elevating the polar lands. If such a pulsating action recurs in geological time there could be accentuation, modification, or eradication of the effects of earlier pulsations. Tectogenes might develop during the pulsations from sphere to oblate spheroid.

When the earth had a much thinner sedimentary cover, shrinkage, by cooling, to the extent of the thickness of a sheet of paper each year would give 264 ft shrinkage in diameter in 2,000,000 years, causing a loss in area of 5000 sq ml, and a volumetric change of 10,000,000 cu ml. This would account for quite a number of mountain masses. G. D. H.

**2. Exploration in Pacific Northwest Draws Interest.** Anon. *Oil Gas J.*, 11.8.45, **44** (14), 82.—Mechanical difficulties have caused the abandonment of a third test near Aberdeen, Gray's Harbor County, Washington.

Geophysical work is being carried out in the Willamette Valley of Oregon. The Texas Co. 1 Clatskanie is being drilled in Columbia County, Oregon. G. D. H.

**3. Seeligson Field Outstanding on Several Counts, Especially its Multiple Pay-Zones.** C. J. Deegan. *Oil and Gas J.*, 11.8.45, **44** (14), 74.—The Seeligson field on the Jim Wells–Kleberg County line has tentatively shown some 40 separate oil and gas reservoirs in the Frio and Vicksburg, down to 6800 ft. The present proven area is 14,000 acres, with recoverable reserves estimated at 325–500 million barrels, with 1000–1500 thousand million cu. ft. of gas.

The early wells were drilled on reflection seismograph and gravity data, and in 1933 the West Premont field was found. A new geophysical survey showed the main structure to lie the east, and in 1937 the real discovery well of the Seeligson field was completed, flowing 912 brl of 36° gravity oil from the Vicksburg at 6585–6595 ft. The field is an anticline on the Vicksburg Flexure trend. The anticlinal fold is formed by closure on the downthrown side of a regional fault-zone. There are two highs. The lenticular producing sand zones cover a section ranging 4300–6800 ft deep. 21 of the pays give oil and gas; the others may eventually give gas and condensate. The average well finds four gas-zones and three or four oil-zones. The sand development seems better in the south.

Development may eventually be on a 20-acre spacing with dual oil completions, with only one well to 40 acres for any oil-zone.

Reservoir pressures are normal in the shallower zones, but the gas-zones at about 6250 ft are as much as 500 lb/sq in above normal. Average porosity of good oil-sand is 25%, with vertical and lateral permeabilities ranging 0–1200 md. There is no positive evidence yet of water-drive. Production has been about 50,000 brl/lb/sq in pressure drop.

In casing 1000 ft of surface pipe is set, with a 5½-in or 7-in oil-string at 6000 ft. Contract drilling prices are about $3·00/ft. Each well requires about $1000 worth of special muds.

Plans are being made for unitization of the gas and condensate zones. There is a possibility of recycling gas to the lenticular oil-zones. G. D. H.

**4. North Carolina becomes Focal Point of Oil Search after 20-Year Interval.** W. B. Hill. *Oil Wkly*, 17.9.45, **119** (3), 50.—Successful wildcats in Mississippi, Alabama, and Florida have led to leasing on the Atlantic Coast from Florida to Maryland and Delaware. A test near Havelock in North Carolina in 1924 was abandoned in granite at 2415 ft.

In the extreme east of the State about 2,700,000 acres are under lease. Near North Morehead City, Carteret County, a second test has been drilled. It was abandoned in granite at 4044 ft. The Trend Marl Miocene was topped at 335–374 ft, the top of the Cretaceous possibly at 1398 ft or higher, and the Tuscaloosa or younger at 2262–3678 ft.

Only the eastern area of North Carolina is now considered favourable for oil production. Granites and strongly metamorphosed sediments outcrop westwards from Wilson. Two tests have found Miocene, Eocene, Upper and Lower Cretaceous, the latter formation being deemed most favourable for oil production. The Pennsylvanian and Mississippian may also be favourable. The likely structures are fault-traps, shore-line traps, and arches, over granite ridges especially.

A map shows the main areas leased. G. D. H.

**5. Wildcat Completions Decline.** Anon. *Oil Wkly*, 1.10.45, **119** (5), 49.—During August U.S. exploratory completions averaged 85 per week; the July figure was 90 per week. The average for the first eight months of 1945 was 82·8 per week, a figure which is only 2·8% above that for the corresponding period of 1944.

The August wildcat completion results are summarized by States and districts; comparable figures are given for the first eight months of 1945. The types of discoveries are analysed for July and August, and for the first eight months of 1945 and 1944. The August discoveries are listed with pertinent data. G. D. H.

**6. Ratio of Wildcatting Success Betters Eight-Year Average.** Anon. *Oil Wkly*, 30.7.45, **118** (9), 47.—11·6% of the strict wildcats drilled in U.S.A. in the first half of 1945 were successful. This is slightly better than the 11% average for the preceding eight years. In the first half of 1945 strict wildcats represented 15·6% of all wells. The corresponding average for 1937–44 was 11%. The proportion of wildcats and the degree of success varied in different states.

No unusually large fields are among the 1945 finds. West Texas has 13 oil discoveries, 3 being in the Devonian. Some of the strikes give high-gravity sweet crudes.

Brief notes are given on the results of wildcatting in the various sectors of U.S.A. during the first half of 1945, and a table summarizes the results and gives comparative figures for the period 1937–44. G. D. H.

**7. Wildcat Completions Decline in Rate of Increase.** Anon. *Oil Wkly*, 27.8.45, **118** (15), 49.—In the first seven months of 1944 U.S. exploratory completions totalled 2468; in the corresponding period of 1944 the figure was 2422. It is doubtful whether the P.A.W. goal of 5000 wildcats in 1945 will be reached. 464 productive tests have resulted from the 1945 wildcatting. There has been a gain of 125% in new pay discoveries and a gain of 157% in distillate discoveries as compared with the first seven months of 1944.

In 1943 the average cost of drilling a well was about $37,000; in 1940 $27,182 and in 1937 $26,183. In 1944 about 7 out of 10 completions were dry; in 1937–41 the dry-hole ratio was one to every four or five wells drilled.

There were 390 exploratory completions in June 1945 and 355 in July.

Tables summarize the wildcat completion results in July and in the first seven months of 1945. Totals are given for different types of wildcat and of discovery, and the July discoveries are listed with some details. G. D. H.

**8. Exploratory Drilling Record to be Near P.A.W. Goal for 1945.** Anon. *Oil Wkly*, 30.7.45, **118** (9), 53.—In the first half of 1945 exploratory well completions averaged 81·5/week, and in the first half of 1944 75·7/week. If continued at the same rate, 4600 exploratory wells should be completed in 1945, 400 below the P.A.W. goal. 18·7% of the wells have been productive.

June exploratory completions average 96·3/week, 15·6% being successful. Tables summarize the exploratory drilling results in June and during the first half of 1945 by districts, and classify the overall figures according as they are extensions, and oil, gas, or distillate field or pay discoveries. The June discoveries are tabulated with some details. G. D. H.

**9. Who is Drilling the Wildcats?** Anon. *Oil Wkly*, 30.7.45, **118** (9), 51.—An analysis of the total and exploratory drilling results in U.S.A. for the first half of 1945 shows that the larger and smaller companies are finding new oil-fields in about the same ratio as that of their total drilling, but the latter have a relatively lower success ratio (16·3% against 24% for the larger companies). Of the total wells drilled by 32 large

companies, 13·7% were strict wildcats, while the figure for the rest of the industry was 16·5%. Among the large companies results and figures vary widely. The data are tabulated in detail. G. D. H.

**10. English Test Fails.** Anon. *Oil Wkly*, 24.9.45, **119** (4), 79.—At North Creake, 7 ml northwest of Fakenham, Norfolk, a test well failed to show oil, and was abandoned in Pre-Cambrian at 2632 ft. G. D. H.

**11. British Columbia Reports Showings of Oil and Gas.** Anon. *Oil Wkly*, 15.10.45, **119** (7), 70.—The discovery of natural gas and evidences of petroleum in the Boundary Bay region of British Columbia has been reported. G. D. H.

**12. Mexican Wildcat Producer Wakens Sleeping Industry.** Anon. *Oil Gas J.*, 8.9.43, **44** (18), 80.—1 Soledad has been completed by " Pemex " as a 50-brl wildcat 25 ml west of the Golden Lane. The well reached 6480 ft and found 40-gravity oil in the same sand as is present in the fields of the Tampico area.

1 Mission has opened a new gas-field near Reynosa, only 300 yd from the Texas border. The initial output was 6,000,000 cu ft and 45 brl of distillate.

Exploration is under way in six untested zones: Coahuila, Chihuahu, and Nuevo Leon, in northern Mexico; Tamaulipas, between the San Carlos mountains and the Gulf Coast; parts of Vera Cruz, Chiapas, and the Yucatan Peninsula, southwest Mexico; Oaxaca and Guerrero, southern Mexico; Nayarit and Sinaloa, west coast and southern Lower California. G. D. H.

**13. Casabe Pay Proven under Tropical's De Mares Pool.** Anon. *Oil Gas J.*, 11.8.45, **44** (14), 78.—1 Galan on the east bank of the Magdalena is reported to have shown about 1000 ft of oil-pay section in an electrical survey, with assurance of production. G. D. H.

**14. Sixth Dificil Well Sets Production Record.** Anon. *Oil Gas J.*, 25.8.45, **44** (16), 102.—6 Dificil lies 1000 m west and 500 m south of 1 Dificil. It gave 1200 brl/day of 42° A.P.I. gravity oil on a $\frac{3}{8}$-in choke. The Dificil field, lying 90 ml from the port of La Gaira, has 5 producers with a combined potential of 2750 brl/day. G. D. H.

**15. Venezuelan Exploration Covers Extensive Area.** M. C. Cody. *Oil Gas J.*, 11.8.45, **44** (14), 76.—Creole has made a discovery, 1 Capacho, 30 km southwest of Mulata. South America's deepest well has reached a depth of 13,033 ft, in the heart of the old Cabimas field on the east shore of Lake Maracaibo. An outpost is being drilled in the newly discovered Mara field which has only one producer and lies 25 km northwest of Maracaibo. 25 km east of Lagunillas, the 1 Ballenato wildcat is drilling at 8350 ft.

The Venezuela Atlantic Refining Co. is drilling 2 wildcats, 1 Morichito and 1 Punta Gorda, north of the Santa Barbara-Jusepin producing area. On the Delta Amacuro concession the Texas Petroleum Co. is drilling a third test. The first well was dry and the second a producer. G. D. H.

**16. New Venezuelan Field Discovered by Creole.** Anon. *Oil Gas J.*, 28.7.45, **44** (12), 112.—1 Capacho has opened a new field in Anzoategui, 30 ml southwest of Mulata. The production is 150 brl/day of 23° oil from 4410–4470 ft. G. D. H.

**17. Brazil has Four Oilfields with 25 Producing Wells.** A. I. de Oliveira. *World Petrol.*, Sept. 1945, **16** (10), 74.—Early geological studies indicated favourable structures for oil near La Bahia de Todos os Santos. This region has a graben with Cretaceous, Jurassic, and possibly older beds down-faulted against Archæan. There is folding roughly parallel with the faults. Geophysical work was undertaken. Several dry holes were drilled in Alagoas, but two had oil-showings. In Bahia, the Lobato, Candeias, Aratu, and Itaparica oilfields were found. Lobato is a relatively steep westerly-dipping monocline with a major fault on the east, and subsidiary faults breaking it into blocks. Seven producing wells have been completed, oil being found in a sand at about 650 ft. The biggest well, an 80-brl pumper, has yielded the bulk of the 65,000 brl of oil obtained since 1940. 15 ml north of Salvador is the Aratu field, on an

elongated dome. Oil is obtained at 1500–1600 ft, and gas 500 ft deeper. The oil is in a silty sandstone lens at the southern end of the dome, the lens covering 30–40 acres. Three oil-producing wells have a total potential of about 100 brl/day. The gas-sand may cover 1000 acres. Eight gas-wells have potentials ranging 1–8 million cu ft/day. 15 ml to the northwest is the Candeias field, on an asymmetrical anticline with steep easterly dips. The field has 11 producers at depths of 2600–4000 ft. Oil is found in a 100-ft section of hard, coarse grit or sand. The proved area on this structure covers 1000 acres, and is limited on the north and west by wedging out of the sand. The present potential is about 1200 brl/day.

The Itaparica field produces gas from the western end of a lens and oil from the eastern end. There is a deeper oil-sand with oil in the topmost 30 ft. The total potential of the wells in the upper zone is 500 brl/day, and that of the wells in the lower zone 300 brl/day.

Two wildcats within 50 ml of Salvador have had oil-showings. Two wildcats near Maceio found thick sections of depleted oil-sands at depths of 2500–5000 ft.

G. D. H.

## Geophysics and Geochemical Prospecting.

**18. Structural Interpretation of Micromagnetic and Other Data.** W. P. Jenny. *Oil Wkly*, 8.10.45, **119** (6), 40.—The interpretation of micromagnetic surveys at Ravenna (Michigan), Cumberland (Oklahoma), Ganada, Pinehurst, Odem (Texas), and Egan (Louisiana) is discussed, all the surveys having been made prior to discovery of the structure. A few wells had been drilled before the surveys were made at Hawkins (Texas).

Generally micromagnetic local positive anomalies indicate structural highs under certain regional magnetic conditions, and structural lows under others. However, in regions where positive anomalies indicate structural highs a salt uplift may be represented by a local negative anomaly. Faulting may bring in a strongly magnetic bed. In areas where the local micromagnetic anomalies are due to beds in the sedimentary column, these anomalies are essentially produced by the shallowest magnetic bed which is sufficiently displaced from its normal position by the local structural conditions.

G. D. H.

**19. The War's Influence on Geophysics.** A. R. McTee. *Oil Wkly*, 10.9.45, **119** (2), 59.—It is generally believed that no revolutionary or basic change or improvement in geophysical methods or equipment can be expected from the war. However, equipment will be lighter, better controlled, and will probably have greater sensitivity—improvements which are part of the normal growth of geophysics.

War-time developments in electronics may show up in the construction of electronic geophysical equipment. Magnetic surveying instruments for use in aircraft are likely to be developed soon. It may be possible that radar can be used as a correlating medium between geochemistry and geophysics, for it has now been established that the soil character is affected by deposits of oil beneath.

Aerial surveying may make wide use of colour photography as an aid in correlation.

A portable gravity-meter which together with batteries weighs only 45 lb has been constructed.

Geophysical prospecting practice may be changed by war-time developments such as improved transportation, air transport of heavy equipment with its possibilities for isolated regions, the use of light metals in auxiliary equipment, improvements in explosives and the methods of handling them, and advances in communication equipment and procedures.

The comfort of geophysical crews may be increased by war-time developments in clothing, equipment, insecticides, etc.

Experiments are being made on the Gulf Coast by burying thermometers and noting differences in soil temperatures, as a means of locating structures. The idea is based on differences in thermal conductivity. Due to the high conductivity of salt, the soil above salt-domes has a temperature several degrees above that of more remote soil.

During the war there has been a great advance in the use of a gravity-meter for operations in water-submerged areas.

G. D. H.

## Drilling.

**20. Directional Drilling Used as Exploratory Tool in Gulf Coast Well.** E. H. Short, Jr. *Oil Gas J.*, 8.9.45, **44** (18), 111.—This article describes a recent application of directional drilling as a means of subsurface exploration. Although the productive horizon sought was penetrated on the second attempt, this particular case illustrates the possibilities in this type of work. The success of the bit-control method employed in the directional drilling of this well is best indicated by the fact that it was necessary to run the directional tool only five times during the complete drilling procedure of the final hole. During this job, when greater inclination was needed, the drill-collar assembly was shortened and drilling operations conducted with more weight upon the bit. If less inclination were desired, the drill-collar assembly was increased to a length slightly greater than 60 ft and less weight was carried on the bit. In the first case the drill-pipe tended to bend, and in the second case it was stiffened and had a tendency to run straight. During the final stages of drilling the inclination of the hole reached an angle of almost 10°, which would have thrown the course off the target. While approximately 500 ft above the target the drag-bit was replaced with a rock-bit and the drill-collar assembly lengthened. After the installation of this equipment the angle of inclination dropped steadily from approximately 10° to approximately 1°, at the point where drilling operations were stopped in the pay section. A. H. N.

**21. Special Mechanical Safeguards Installed on Deep Drilling Rig.** N. Williams. *Oil Gas J.*, 8.9.45, **44** (18), 86.—Safety measures in use on this large steam-powered rig include dual installations for main operating units. Among these are an auxiliary and standby draw-works and engine, a spare rotary, an extra swivel, and duplicate main mud-circulating lines, as well as steam lines in some cases. Steam power for the rig is supplied by five 125-hp 350-psi working-pressure boilers, equipped with automatic water level, fuel-feed, and blower controls. A. H. N.

**22. Substructure-Design Innovations Feature Modern Diesel-Powered Rig.** N. Williams. *Oil Gas J.*, 20.10.45, **44** (24), 125.—The devices and practices adopted for controlling and protecting wells during drilling by means of two diesel-powered rigs are described in some detail. A. H. N.

**23. Rowan Initiates Post-war Diesel-Electric Rig Layout.** E. H. Short, Jr. *Oil Gas J.*, 13.10.44, **44** (23), 100.—The rig is designed for deep drilling in localities where water and gas are scarce. The paper is photographically illustrated. A. H. N.

**24. Two 24-Cylinder, 2-Cycle Quad Diesel Units Drilled Oklahoma's Deepest Well.** K. B. Barnes. *Oil Gas J.*, 15.9.45, **44** (19), 103.—Details of the drilling engines, and of their controls and maintenance are given. A. H. N.

## Production.

**25. The Optimum Rate of Production of Oil, Condensate, and Natural Gas.** Part 1. P. J. Jones. *Oil Gas J.*, 1.9.45, **44** (17), 50–52.—The optimum rate of production from reservoirs depends on several factors. The reserve is probably the most important. A reserve varies with producing and operating methods, but it may also depend on the rate of production. Reservoirs for which reserves vary with the rate of production are said to have a maximum efficient rate or MER. The MER may influence optimum rates of production through the size of reserve, operating expense, and required investments. The rate of production for which the present value of a reserve after taxes, royalty, operating expenses, and investment is a maximum defines the optimum rate of production. The investment in reservoirs, required in order to produce at optimum rates, depends on the ratio of annual/well producing rate to/well investment. This ratio and the income/thousand cu ft, or barrel, of gross production after taxes, royalty, and operating expense fix the optimum rate of production for a reserve recoverable at declining rates of production is higher than for a reserve recoverable at uniform rates of production. The initial rate of production corresponding to optimum conditions ranges from about 5 up to about 11% per year of an initial reserve. Some of the elements of optimum producing rates are illustrated. A. H. N.

**26. The Optimum Rate of Production.** Part 2. P. J. Jones. *Oil Gas J.*, 8.9.45, **44** (18), 103.—The optimum rate of production from reservoirs usually does not exceed the maximum efficient rate of production, the MER. Other things equal, the MER varies with the distribution of reserve in reservoirs. The initial MER depends on the initial distribution of reserve. The MER corresponding to, say, 50% of the initial reserve depends on the distribution of reserve after 50% of the initial reserve is recovered. The MER may vary with time. It depends on the variation with time of reserve distribution. The distribution of reserve in a reservoir at a given time may vary areally and sectionally. Areal and sectional variation of reserve depends on the direction of advancement in reservoirs. The direction of most interest to producers is the one parallel to dip. A decrease of productive area/ft of updip advancement represents areal convergence of reserve. It also represents areal divergence in the downdip direction. A decrease of pay thickness/ft of downdip advancement would represent sectional convergence of reserve. It would also represent sectional divergence for the updip direction. Reservoirs may be classified according to the shape of their productive area as linear or radial. Linear reservoirs have no areal convergence. Radial reservoirs have areal convergence of reserve in the updip direction. Both types of reservoirs usually have a variable pay thickness—that is, sectional convergence is commonly in the downdip direction. The effect of areal and sectional convergence on the distribution of reserve is illustrated by examples. A. H. N.

**27. The Optimum Rate of Production.** Part 3. P. J. Jones. *Oil Gas J.*, 15.9.45, **44** (19), 81.—The optimum rate of production from reservoirs usually does not exceed the maximum efficient rate, the MER. The MER for displacement of oil by water may be variously expressed. But the rate of advancement of oil–water interface parallel to bedding probably has more applications than any other method. Field experiences with displacement of oil by water under various conditions indicate that 200 ft/year parallel to bedding is about the maximum rate of interface advancement for most reservoirs. However, an exceptionally cavernous limestone reservoir and a homogeneous sandstone reservoir, if one were discovered, could have a faster rate of water advancement without bypassing oil. The rate of oil production, the MER, corresponding to a 200-ft/year rate of interface advancement depends primarily on areal and sectional convergence of reserve. The MER may influence the size of an initial oil reserve and well-producing capacity. The latter, in turn, influences investments in reservoirs and operating expenses. For these reasons, the MER is a significant element in producing some reservoirs at optimum rates. This article is limited to displacement of oil by water at reservoir pressures which are higher than the saturation pressure for oil. The corresponding MER for linear and radial reservoirs is illustrated by examples. A. H. N.

**28. The Optimum Rate of Production.** Part 4. P. J. Jones. *Oil Gas J.*, 22.9.45, **44** (20), 317.—The MER for displacement of oil by gas may be variously expressed. But the rate of advancement of gas–oil interface parallel to bedding probably has more applications than any other method. Gravity may displace oil relative to gas provided the downdip rate of gas–oil interface advancement is not too fast. The rate of oil displacement by gravity relative to gas is highest at no free gas saturation. After a gas–oil interface invades a given section of pay, the rate of oil displacement by gravity from that section decreases rapidly. Gravity does not increase oil recovery. It reduces the volume of gas required to achieve a desired oil recovery, provided gas–oil interfaces advance downdip and the rate of advancement is not too fast. Field experiences with displacement of oil by gas under viscous conditions indicate that 200 ft/year parallel to bedding is about the lower limit of interface advancement for most reservoirs. If gravity is not effective at 200-ft/year rate, it is not likely to be significantly more effective at a slower rate. In reservoirs having a comparatively high permeability or a steep dip, gravity may be effective at rates of interface advancement faster than 200 ft/year is included. The MER corresponding to 200-ft/year is illustrated by examples. The MER varies with the initial position of a gas cap. The MER for displacement of oil by gas may influence optimum rates of production through size of reserve, required investments, or operating expenses. A. H. N.

**29. The Optimum Rate of Production.** Part 5. P. J. Jones. *Oil Gas J.*, 29.9.45, **44** (21), 111.—Optimum rates of production vary with investments. Other things

equal, investments in reservoirs depend on well-producing capacity. The well-producing capacity for a reservoir declines with a decrease in the number of producing wells and with a decrease in per-well producing capacity. The relationships between well-producing capacity and reserve are characterized by reserve raised to some power $p$. Cycling and pressure maintenance projects may be defined by small values of $p$. Production of oil by evolved solution gas may be defined by values of $p$ which are large compared to those for cycling operations. The relationship between well-producing capacity and the reserve for a given reservoir depends primarily on producing and operating methods. If wells are produced at capacity, the relationship between well-producing capacity and time may be obtained from that reserve and well-producing capacity. Some of the relationships found in practice are illustrated graphically. A. H. N.

**30. The Reserve for Displacement of Oil by Gas at Declining Pressures.** Part 7. P. J. Jones. *Oil Gas J.*, 13.10.44, **44** (23), 119.—The reserve for displacement of oil by gas at declining pressures may range from as low as 15% of the oil initially in place up to about 45% of the oil initially in place. This possible threefold range of oil recovery by gas displacement at declining pressures results from the wide variation found in the field as to the properties of fluids, characteristics of reservoirs, and producing and operating practices. This article reviews the effects of gas–oil ratios, pressures, and location of wells on oil recovery by gas displacement. From the viewpoint of the optimum rate of production, the effect of distance from the source of gas to producing wells should be emphasized. Other things equal, the volume of gas required in order to achieve a desired oil recovery may be reduced significantly by providing sufficient distance between the source of gas and producing wells. The required distance can be provided under co-operative or unit operations. A. H. N.

**31. The Optimum Rate of Production.** Part 8. P. J. Jones. *Oil Gas J.*, 20.10.45, **44** (24), 147.—The initial reserve for displacement of oil by water at declining pressures may increase with free gas saturation up to about 10% of porosity. On the other hand, a decline in reservoir pressure is accompanied by a decrease of well-producing capacity. Consequently, if wells are produced at capacity, the increase in recovery from some reservoirs may not offset the increase of investment necessitated by the declined well-producing capacity. But, if per-well producing rates are limited to, say, 20% of their initial producing capacity, it may be advantageous to decline reservoir pressure down to a value at which enough solution gas evolves to occupy about 10% of porosity, provided the resulting rate of water advancement does not exceed about 200 ft per year parallel to bedding. The possible variations of initial reserve for displacement of oil by water at declined pressures are reviewed. A. H. N.

**32. Peak-Torque Method of Rating Oilfield Belting.** D. O. Barrett. *Oil Wkly*, 8.10.45, **119** (6), 52–53.—In a well pump in which $W$ = well load, lb; $CB$ = counterbalance, lb; $a$ = distance of centre of gravity of beam counterbalance from fulcrum of beam, ft; $A$ = distance of load from fulcrum, ft; $r$ = radius of crank-throw, in; $R$ = radius of bandwheel, in; $K$ = belt width, in; $ST$ = static tension/in width of belt = (usually) 125 lb; $MR$ = manufacturer's rating of belt loading/in width, lb; then :—

$$\text{Net } CB \text{ effect} = \frac{CB \times a}{A} = NCB;$$

$$\text{Peak torque} = (W - NCB) \times r = PT;$$

$$\text{Net belt pull} = \frac{PT}{R} = NBP;$$

$$\text{Net belt pull/in Width} = \frac{NBP}{K} = PIW;$$

and

$$\text{Total belt load/in Width} = PIW + ST = TBL.$$

Loads should be such that $TBL = MR$, where $MR$ is based on 100 million shock loads, which corresponds to a life of 5 years at 20 strokes/min on a beam pumping-well. A. H. N.

**33. Marble Torpedoes Prove their Worth.** A. Gibbon. *Oil Wkly*, 8.10.45, **119** (6), 36–39.—Although primary interest in the marble torpedo was its ability to clean

thoroughly the face of the well-bore by removing congested solids and permitting the well so treated to respond to its full capacity, new uses and rather surprising results have been reported during the past year. Some of the best results have been obtained in old fields where wells have been producing for 30 or even 40 years. One small well near Caney, Kansas, had been producing for years at the rate of ¼ brl of oil daily, but after a marble shot it increased to 8 brl/day, and the owner is now preparing to treat additional wells. Near Drumright, Oklahoma, was a well that had been producing for a number of years and which ten years previously had been given a heavy shot of liquid explosive which increased production at the time to 25 brl/day, and later declined to 2 brl with the immediate field of vacuum. It was given a " marble shot " some months ago, immediately increasing the production to 50 brl/day, which has since settled to 31 brl/day. In New York State a 46-year-old gas-well making 10,000 cu ft of gas daily increased production to 83,000 ft of gas daily, after it was given a 5-ft " marble shot." The marbles torpedo has proved equaly effective in soft, muddy wash. A wash-well in the Bowers pool in the Panhandle area, which is also a low-pressured mud area, became congested and paraffined and was about to be abandoned. When tubing was pulled the complete liner was found to be cemented with salt and gyp, and was pulled up with the tubing. The paraffin and salt made it impossible to distinguish either the collars or perforations in the liner. When the well was cleaned there was only a slight increase of seepage from the congested walls. The well was treated with 80 ft of marbles and cleaned out without the difficulty expected in continuous caving as from a conventional shot. The well has averaged 132 brl of oil daily for several months. The theory and operation of the torpedoes are given.

A. H. N.

**34. Glass Marble Torpedo Used to Shoot Wells.** J. Gordon Burch. *Petrol. Engr*, Sept. 1945, **16** (13), 216.—The cleaning of wells by shooting with marble-packed torpedoes is described in detail. The development of the scheme is given. In the first experiment, in 1944, ordinary glass marbles were used. A hole 14-in in diameter was dug in black top soil, and the first " agate " torpedo was exploded. The walls of the hole, other than showing a regular pattern of hits, were not disturbed. After carefully peeling back the bank for several feet, the marbles were found still round, but disintegrated to white sand by the heat of penetration. They had not changed in size, and retained a gloss coating, but they could be pulverized easily by squeezing them with the fingers. From many experiments much was learned about marbles. Common glass has a much greater crushing strength than any oil-producing formations, and it is very elastic. A glass marble was thrown against seasoned concrete without breaking. Then the shot in a shot-gun shell was replaced with a marble, and at distances of 15–25 ft it was fired against seasoned concrete, and in no case did the marble break. Chips of cement the size of a saucer were knocked off, but the marble was unharmed. In a well where the marbles were propelled by nitroglycerin, however, the marbles reach the wall of the well with such high velocity that they penetrate even the hardest formation to some extent. When the resistance of the formation checks the speed of the marbles, they disintegrate violently with a blasting effect towards the centre of the well-bore. The marbles break up into particles of glass about the size of a pinhead. Evenly-sized heat-treated glass marbles are now being used to lace around the explosive container to avoid the slightest overlapping.

In shooting in shallow, large-diameter cement vats, where the explosive gases could escape readily, the marbles alone destroy the surface of the solid cement to a depth of 2 in. The destructive force of the marble is even greater where the explosive gases are retained, as in a well. The method of running the torpedoes and detonating it are given.

A. H. N.

**35. Salt-Water Disposal in East Texas.** Anon. *Petrol. Engr*, Sept. 1945, **16** (13), 86.—A discussion of centrifugal pump characteristics, working with water, is given. Installation and maintenance of pumps and prime movers are discussed. A. H. N.

**36. Salt-Water Injection for Pressure-Maintenance in East Hackberry Field, Louisiana.** M. L. Euwer. *Oil Gas J.*, 29.9.45, **44** (21), 100–102.—A co-operative project of water injection for pressure maintenance undertaken jointly by three concerns is described. The development of the field is reviewed together with its production history and methods.

A. H. N.

**37. Water Injection in the Chatham Field, Medina County, Ohio.** R. B. Lyon and J. Cashell. *Oil Gas J.*, 1.9.45, **44** (17), 58.—The Chatham field is relatively small, the sand conditions are far from uniform, and the injection of water under pressure for secondary recovery has been carried on for only 5 years. Based on cable-tool and diamond-core analyses, the average conditions warrant the use of water injection for the development of this field. The unusually erratic occurrence of the sand, wide range of permeabilities, had great variation in saturations result in a wide range of input volumes of water which must be regulated annually at the individual well-head. The varied sources of water supply require chemical treatment and sand filtration. It is found that water pressures on the sand face of 1 psi/ft of overburden can be used in flooding the Berea sand in the Chatham pool if there is no channelling action. Satisfactory results are obtained by using a shot in all wells of 1 qt of nitroglycerin/ft of sands. Selective shooting has not definitely proved a satisfactory equalizer of vertical sand characteristics, and does not control the flood-front to an effective degree. A brine-disposal problem will always exist; therefore, filtration and treatment equipment must be set up to take care of this water, so that it can be used as a pressure medium in the Berea sand by recycling. When brine is used as a pressure medium, corrosion is present, and must be reduced to a minimum if water-pressure systems are to continue to operate throughout the life of the field. Corrosion can be prevented by treating the water with lime at the filtration plant and deo-oxygenization. The low price received for oil in this field makes certain portions of the field unfloodable.

A. H. N.

**38. Periodic Tests Insure Injection-Water Quality.** J. R. Wright. *Oil Gas J.*, 15.9.45, **44** (19), 78–79.—It is widely known that a perfectly clear water may not be entirely suitable for injection purposes. However, the exact nature of reactions which occur due to injection and mingling of waters is not well understood. Application of stability-index calculation shows the characteristics of a stable water at formation temperature, and provides a definite control for quality of injected water. Some examples are shown which illustrate in a practical manner the results of injecting unstable water and the use of stability index calculations for corrective and preventive measures.

A. H. N.

**39. Secondary Recovery in California.** R. Sneddon. *Petrol Engr*, Sept. 1945, **16** (13), 66.—An experimental project of water-flooding the Chapman Zone of Richfield in California is described and a number of conclusions, based on experience to date, are reached. First, it is seen that oil in the Chapman zone at Richfield can be displaced with water, and that water-flooding is an effective medium for secondary recovery in that section of the reservoir. Second, it has been demonstrated that water injection can be sustained over a considerable time if flocculable material is first removed. No report has yet been forthcoming on the economics of the process—and it is therefore impossible to say whether or not the experiment as conducted on a small scale can be profitably conducted on a large scale. A. H. N.

**40. Some Factors Entering into Pumping Unit Walking Beam Selection.** R. N. Mills. *Petrol Engr*, Sept. 1945, **16** (13), 112.—Velocity and acceleration diagrams and data on torque and peak loads for different layouts of a pumping unit are presented and analyzed. The peak torque values obtained indicate that for the conditions investigated the beam-working centres have little effect on torque values, as the indicated result is a reduction in the peak torque load. As this investigation did not include all types of unit geometry, definite dimensional limitations cannot be drawn, but it should be noted that relatively long pitmans were used on all machines investigated. These long pitmans were used because it is believed that the length of the pitman is one of the predominating factors affecting the operation of the pumping unit. This belief is based on the fact that the motion of the upper end of the pitman would be simple harmonic if the pitman length were infinite.

Although the lowest acceleration rate was found on geometric layouts with long working centres, the difference between the values of the acceleration factors is small. The effect of acceleration on well load is not a definite quantity. According to the best theory, polished rod acceleration is unimportant, because its contribution to the total well load is very small. The only disadvantage of the short-beam long-stroke

pumping unit is the fact that it is limited to wire-line-type beam hangers. The wire-line-type beam hangers will not give satisfactory service if the well load becomes zero at any point in the pumping cycle. This fact places a definite limitation on the pumping speed, because when an oil-well is pumped at a speed exceeding about 26–30 spm, the well load will be zero at some point in the stroke, and wire-line failures will occur. If a pumping unit with a short walking beam is applied to the problem of pumping an oil-well at a slow speed with a long stroke, however, this disadvantage will not exist. A. H. N.

**41. Significance of Declining Productivity Index.** C. V. Millikan and H. Beardmore. *Oil Gas J.*, 29.9.45, **44** (21), 123. See Abstract No. 1295 (1945). A. H. N.

## Oilfield Development.

**42. World's Oil Position as the War Ends.** R. Sheldon. *World Petrol.*, Sept. 1945, **16** (10), 52.—A table gives the production to date, the present proven reserves, the probable ultimate resources, and the division of the ownership of the oil in U.S.A., the Caribbean Basin, the rest of South America, Canada, Alaska, Russia, rest of Europe, Middle East, Africa, Southwest Pacific, and the rest of Asia.

The world production to date exceeds 46,600 million brl; proven reserves total 63,000 million brl, 32% of which are in U.S.A., 42% in the Middle East, 9% in Russia, and 13% in the Caribbean Basin. U.S.A. owns 57·7% of the world's reserves, Russia 9%, and the British and Dutch together 28·7%. G. D. H.

**43. Average Well Depth Greatest in History.** Anon. *Oil Wkly*, 30.7.45, **118** (9), 50.—In the first half of 1945 the average depth of the 12,142 U.S. completions was 3568 ft compared with 3314 ft for the whole of 1944. Sharply increased development in California, and in Texas and other States in the southwest is mainly responsible for the increased average footage per well in 1945 and 1944.

322 wells completed in South Louisiana in the first half of 1945 averaged 4385 ft each. The Upper Gulf Coast of Texas had an average of 7277 ft/well.

Data on completions, footage, and average depths are tabulated by States and districts, and U.S. over-all figures are given from 1925 onwards. G. D. H.

**44. Production Increases 56,440,000 Brl.** C. J. Deegan. *Oil Gas J.*, 28.7.45, **44** (12), 124.—In the first half of 1945, Texas, California, Oklahoma, and Wyoming showed substantial increases, while Illinois, Kansas, and Pennsylvania showed declines in output.

Tables give the production by States in the years 1940–44 and in the first halves of 1944 and 1945; the monthly outputs of the Districts of Texas in the first halves of 1944 and 1945; and a list of the Texas fields which have shown substantial rises in production. G. D. H.

**45. Completions Near P.A.W. Schedule of 27,000.** Anon. *Oil Wkly*, 30.7.45, **118** (9), 58.—In the first half of 1945 completions averaged 467/week, 12·4% more than in the first half of 1944. The number of rigs in action has been consistently higher than in 1941, but worn rigs, less efficient labour, greater depths, etc., have given a lower completion rate. Compared with 1944, completion rates have risen in Texas (26%), Louisiana (40%), Colorado (11%), California (11%), and Michigan (26%).

Tables give the weekly average rate of completing wells and the numbers of active rigs in U.S.A. monthly from 1941 onwards, and completion details in June 1945 and during the first half of 1945. G. D. H.

**46. More Wells Proposed by Industry in Second Six Months.** H. S. Norman. *Oil Gas J.*, 28.7.45, **44** (12), 118.—There are indications that 15,000 wells will be drilled in U.S.A. in the second half of 1945, thus giving a total for the year in excess of the 27,000 proposed by P.A.W. Over 2500 wildcats are expected to be drilled, compared with 2055 in the first half of 1945.

Data on completion types in the first half of 1945 are given by States and districts, with predicted figures for the second half. G. D. H.

**47. Well Completions Increase 12·9 Per Cent First Half of 1945.** C. J. Deegan. *Oil Gas J.*, 28.7.45, **44** (12), 121.—12,820 wells were completed in U.S.A. in the first half of 1945. The figure for the first half of 1944 was 11,356. Wildcats totalled 2055. Texas had 3551 completions, 35·6% more than in the first half of 1944; California had 1147 completions and Oklahoma had 1272.

A new pool was opened 2 ml west of Kevin-Sunburst. The Rangely field of Colorado was extended, possibly by 10,000 acres. Elk Hills and Buena Vista Hills were the most active areas in California. Oil-pools were opened at Halsey Canyon, La Habra Hills, and Ramona, and gas-pools at Kirby Hills and North Rio Vista. Eocene production was developed at Capitan, Santa Barbara County.

10 new fields, 7 new pays, and 13 important extensions were made in West Texas. Southeast New Mexico had 5 oil and 1 gas-strike. The Hub, Langsdale, and Sosa fields were opened in Mississippi, and the Falls City gas-field was discovered in Oklahoma. There were 10 new pools in Illinois.

Madison production has been obtained in the Princess-Steveville area of Canada.

The well-completion results in the first half of 1945 are summarized by States and districts, and similar data are given for wildcat completions. The completion results are compared with those of the first half of 1944 for 9 of the leading States.

G. D. H.

**48. Summary of July Completions.** Anon. *Oil Gas J.*, 25.8.45, **44** (16), 173.—2312 wells were completed in U.S.A. during July, 1233 finding oil and 251 gas. The completion results are summarized by States and districts, and data are given on rigs, footage, and the numbers of wells in different depth ranges. G. D. H.

**49. August Rate of Completions Very Little Above Last Year.** Anon. *Oil Wkly*, 17.9.45, **119** (3), 67.—The well-completion rate in U.S.A. in August was 504 per week, 54 per week less than in July. The August 1944 figure was 498. 16,916 wells were completed in the first eight months of 1945, 10·2% more than in the corresponding period of 1944.

In the first week of September the production fell to 4,530,000 brl/day; the all-time peak in mid-July was 4,944,000 brl/day.

A table summarizes U.S. well completion results in August and during the first eight months of 1945, by States and districts. G. D. H.

**50. Weekly Well Completions.** Anon. *Oil Gas J.*, 8.9.45, **44** (18), 129; 15.9.45, **44** (19), 135; 22.9.45, **44** (20), 337; 29.9.45, **44** (21), 157; 6.10.45, **44** (22), 133; 13.10.45, **44** (23), 161.

| Week Ended 1945 | All Wells | | | Wildcats | | |
|---|---|---|---|---|---|---|
| | Oil | Gas | Total | Oil | Gas and Distillate | Total |
| Sept. 1 | 258 | 56 | 476 | 7 | 5 | 61 |
| „ 8 | 284 | 56 | 557 | 16 | 2 | 91 |
| „ 15 | 303 | 54 | 536 | 10 | 4 | 76 |
| „ 22 | 308 | 67 | 596 | 8 | 5 | 90 |
| „ 29 | 323 | 58 | 583 | 15 | 1 | 88 |
| Oct. 6 | 283 | 57 | 552 | 10 | 2 | 92 |

**51. South American Exploration Activity in Full Swing.** K. J. Langley. *Oil Gas J.*, 15.9.45, **44** (19), 60.—Colombia produces 65,000–70,000 brl/day from about 1400 wells in three areas. Barco gives 17,000, and De Mares and Casabe, in the Middle Magdalena Valley, 45,000 and 8500 brl, respectively. 16 wildcats are drilling, and at El Dificil high-gravity oil has been found. 2 San Martin is reported to have struck oil east of the Andes.

Venezuela produces about 960,000 brl/day, one-third of this from Eastern Venezuela. Drilling 9–12 ml out in Lake Maracaibo is not considered impossible. Three new refinery projects of 40,000–50,000 brl each have been announced.

Trinidad yields about 60,000 brl/day from some 7000 wells. There are two important refining units with a combined capacity of 75,000 brl/day.

Four fields in the State of Bahia, Brazil, produce about 800 brl/day. There are 5 small refineries, having a total throughput under 2000 brl/day. Uraguay possesses

a 6000-brl refinery. Argentina produces about 64,000 brl/day from 4100 wells. Comodoro Rivadavia gives 46,000 brl/day from 3300 wells. There are 19 refineries capable of processing a total of 100,000 brl/day. Bolivia has 6 small fields, about 950 brl/day being obtained from the 3 in operation. Chile produces 40,000 brl/day, 33,000 brl/day coming from the La Brea–Parinas area. Considerable interest is being shown in Peruvian areas east of the Andes. Ecuador yields about 7500 brl/day from 900 wells. Tests are being drilled east of the Andes. G. D. H.

**52. Venezuelan Production Record—958,394 Brl Daily.** Anon. *Oil Gas J.*, 28.7.45, **44** (12), 112.—In the week ended July 16 the Venezuelan oil production averaged 958,394 brl/day. Creole produced 506,445 brl/day, Shell 235,966 brl/day, Mene Grande 171,212 brl/day, and Consolidada about 29,000 brl/day. G. D. H.

**53. Creole Venezuelan Well Completions Hold Steady.** Anon. *Oil Gas J.*, 1.9.45, **44** (17), 46.—In July Creole completed 20 oil-wells, 1 gas-well, and a dry hole in Venezuela. The daily production reached the average of 504,163 brl, 58,441 brl/day more than in June. The Lake Maracaibo area gave 340,393 brl/day. G. D. H.

**54. Colombian Exploration Costs are Revealed.** Anon. *Oil Gas J.*, 11.8.45, **44** (14), 78.—Figures for one company's exploration costs show that drilling expenses for each of 13 wildcats averaged $387,000, excluding capital investments, giving a cost of $65·7 per foot. Out of total exploration costs of $11,000,000 in 11 years, surface exploration (geology, geophysics, and mapping) accounted for $3,180,000.

G. D. H.

**55. War Problems of Canadian Oil Industry.** F. G. Jackson. *World Petrol.*, Sept. 1945, **16** (10), 66.—In 1944 Canada produced 8,500,000 brl of oil, but her military and essential civilian requirements were 71,000,000 brl.

Early in the war an organization was created to control the Canadian oil industry. The constitution and aims of this organization are briefly noted. 2 alkylate and 3 cumene plants were built. Wherever possible refineries were modernized, and a 10,000-brl refinery was erected at Clarkson, Ontario. A synthetic rubber plant was built. A number of lake- and ocean-going tankers were constructed.

Increased oil requirements and declining domestic crude production caused steps to be taken to promote exploratory drilling. Leasing and royalty regulations were revised, tax concessions granted, a geophysical exploration programme formulated, and funds were set aside for investigating the Athabaska tar-sands. Many test-wells were drilled, but few were successful. A well in Hillsboro Bay, Prince Edward Island, has reached a depth of 12,800 ft. Little production was obtained from a few shallow wells drilled in western Ontario, and the same was true of Saskatchewan. 54 producing wells were completed in the Norman Wells field. Several wildcats on other structures were dry.

Heavy crude was found at Vermilion and Taber. Conrad is capable of commercial production of 25°-gravity oil, and Lloydminster shows promise of heavy oil production. These fields are, however, unlikely to offset the production decline at Turner Valley. 35°-gravity production has been obtained in the Devonian at Princess, and distillate in the Mississippian at Jumping Pound. Jumping Pound is structurally similar to Turner Valley, and may be a major find.

Turner Valley has produced 73,000,000 brl. Estimates of the ultimate recovery range 105–200 million brl.

It seems clear that only a negligible amount of petroleum products can be obtained from the Athabaska tar-sands within the immediate future, and these only at a cost above that of the present world petroleum supplies.

Gasoline rationing was instituted in Canada in 1942. G. D. H.

**56. Alberta Gas Resources.** F. K. Beach. *Oil Wkly*, 17.9.45, **119** (3), 47.—About 20–25% of Alberta's total population is served with natural gas for domestic fuel. The Calgary–Lethbridge supply system is connected to Turner Valley, and to Bow Island and Foremost; Jumping Pound and Princess may be connected later. In 1944 the consumption was 23 million M.c.f., 11 million M.c.f. being consumed by the Alberta Nitrogen Plant and fields. 18 million M.c.f. was lost in scrubbing and extrac-

tion of natural gasoline and in other ways. Turner Valley reserves are estimated at 300–400 million M.c.f. Bow Island and Foremost each have 15–20 million M.c.f. of reserves. Princess produces from the Sunburst sand of the basal Lower Cretaceous. Its reserves may be 40–100 million M.c.f. In the Sweetgrass Hills area a 50,000-M.c.f. well was completed in 1924, obtaining gas from 3 horizons. The lowest was in the top of the Palæozoic. 2 other wells failed to give gas, but a big gas-flow was found some distance east. It is thought that the large batholith which uplifted the Sweetgrass Hills gave rise to many dykes and sills which have broken up the region into small pockets, so preventing extensive migration, but increasing porosity.

Jumping Pound has 1 producer. It is considerably deeper than Turner Valley, and is unlikely to contain as much gas.

In 1944 the Edmonton system consumed 7 million M.c.f. of gas. Estimates of the reserves of the Viking–Kinsella area range 205–600 million M.c.f. An area running north from the town of Athabasca has shown large gas-flows in wells drilled for oil. It is probable that there is a good reserve, if needed, for Edmonton.

There is a proposal to extend the Viking–Edmonton system as far south as Red Deer.

There are few records of gas consumption for the Medicine Hat–Redcliff area, but the present consumption may be 4 million M.c.f. per year. The limit of the field seems to have been determined in the south and southeast, but not in other directions. Most wells have penetrated only the top of the gas-sand. No sand cores have been taken. It is hoped that the reserves may be 75–125 million M.c.f.

There are other small gas-distributing systems in Alberta. G. D. H.

**57. 1944 Middle East Oil Output at 155 Million Barrels.** Anon. *Oil Wkly*, 24.9.45, **119** (4), 79.—During 1944 the Middle East oil production was 155 million brl, 30 million brl more than in 1939. The expansion of refining facilities makes it likely that the production in 1945 will exceed 200 million brl. The Saudi Arabian production is expected to reach 40–50 million brl during the next year. Oil may soon be shipped from Kuwait. G. D. H.

**58. Anglo–Egyptian Nearly Doubled Yield during War.** Anon. *Oil Gas J.*, 1.9.45, **44** (17), 46.—During 1944 Anglo–Egyptian Oilfields produced 8,048,540 brl of oil, compared with 4,355,280 brl in 1939. During the past 6 years 98 wells, including 3 dry holes, were completed at Ras Gharib. The average depth was 2292 ft. Hurghada produced 881,640 brl in 1939 and 474,225 brl in 1944.

The company drilled 7 unsuccessful wildcats from 1939 to 1944. Two small producers were drilled in the old Gemsah field. Other companies drilled 18 unsuccesful wildcats in the same period.

Production rates at Ras Gharib have been excessive, and nearly 72 million brl has been produced. G. D. H.

**59. One Netherland Well Yields 260 Brl Daily.** Anon. *Oil Gas J.*, 15.9.45, **44** (19), 66.—1 of the 3 wells in Drenthe Province is yielding 260 brl/day. The first producer was completed at about 2500 ft. G. D. H.

**60. Texas Oil Man Visits England's New Oilfield.** E. J. Muth. *Petrol. Engr*, Sept. 1945, **16** (13), 191.—The search for oil in England has involved the drilling of 380 wells of varying depths, in testing 45 separate structural areas. 250 of the wells are producers. Nearly 3 million brl of oil of gravities ranging 19·2–40·1° has been obtained.

The Eakring field is a simple dome with minor faulting and several, sometimes lenticular, oil-sands. Including North Eakring and Duke's Wood, it covers an area 2 ml by ½ ml. All wells are completed in 2 or more of the 4 sands. The oil-horizons are in the Millstone Grit and basal Lower Coal Measures. Porosity ranges up to 20%, and permeability 2–1000 md. The well-spacing is uneven, but averages one well to 2–3 acres.

Drilling has been carried out by heavy-duty steam and diesel rigs, and by light-weight units.

Gas/oil ratios have ranged 56–112 cu ft/brl, and initial pumping production 7–375 brl/day. The gas production is 175,000 cu ft/day. Wells declined rapidly in output until the saturation pressure of the crude was reached.

The high wax content of the oil is troublesome, especially in the top 800 ft. of the

wells. Consequently the top 1000 ft of tubing has been insulated with wooden insulators, and this tubing can be heated electrically to 110° F. by a portable generator, to remove the wax.

Water now represents 60% of the total fluid production. The pumps are electrically driven. G. D. H.

# Refinery Operations.

## Refineries and Auxiliary Refinery Plant.

**61. Recent Progress in the Mitigation of Underground Corrosion.** K. H. Logan. *Oil Gas J.*, 13.1.45, **43** (36), 78.—A brief account is given of the activities of various institutions, societies, and industrial organizations in combating corrosion, particularly as applied to underground pipe lines. The methods employed are discussed under three sections : (*a*) the use of materials which offer greater resistance to corrosion than ordinary ferrous materials—*e.g.*, small percentages of copper, nickel, or chromium in a ferrous alloy impart increased resistance to attack, probably because of formation of a protective film ; such films are seldom continuous and their breakdown results in large cathodic and small anodic areas with accelerated pitting. Copper or alloys rich in copper are more resistant to all soils than ferrous alloys, except those containing high amounts of nickel and chromium. A cement-asbestos pressure pipe is reported, after 4 years exposure to different acids and alkaline soils, to have acquired a slightly higher crushing and bursting strength. (*b*) Cathodic protection. The various methods of its application and different methods of testing are outlined. In sulphur containing earth anodes remain effective until they are consumed, in cases where a higher potential difference is required than obtained between zinc and iron, magnesium can be used instead of zinc. (*c*) Protective coatings. Tests made on lines coated with coal-tar-base materials and asphalt-mastic are recorded, and by the use of the Stearn's Electronic Holiday Detector (briefly described) a marked improvement in protective coatings has been made, the detector showed only one unprotected spot, per mile, one year after the application and laying. W. H. C.

**62. Corrosion Problems in the Petroleum Industry. 4. Zinc as an Anti-Corrosive Pigment. Some Divergent Views.** A. H. Stuart. *Petroleum*, Oct. 1945, **8** (10), 197.—The corrosion of ferrous metals under atmospheric conditions is an electrolytic phenomenon, but the behaviour of zinc and graphite pigments indicates that the problem is complex. Zinc associated with iron, as in an electric cell, will inhibit its corrosion, whereas graphite will promote it, provided the exact conditions are obtained.

In zinc galvanizing a layer of iron–zinc alloy is formed between the iron and the outer surface of the zinc with different properties from those of zinc ; being very brittle. Hence water entering through a crack provides conditions for electrolytic action, the extremely thin film of zinc is soon dissolved and protection ceases.

Tests with zinc and steel in water demonstrate that protection is afforded either by absorption of dissolved oxygen by the zinc, or by zinc ions saturating the water. This second type of phenomenon may be responsible for the many cases where zinc gives protection. Doubt exists as to the anti-corrosive efficiency of zinc pigments, since paint films have a very high electrical resistance. Electrolytic action is impossible if zinc dust is used, as the metallic particles are encased in a self-insulating film, and the chances of the zinc exercising adequate protection are very low. A convenient film for experimental investigations was made from " Aquadag," zinc dust, and water carrying gelatine, the film being electrically conducting.

Sheet iron and steel rods, painted with this mixture, and exposed to water, were free from rust, whilst untreated metals were effected. Such tests showed that zinc is an efficient protective agent provided it is free to exert its electrical and chemical properties. G. A. C.

**63. Evaluation Curves.** W. L. Nelson. (The Refiners Notebook No. 26.) *Oil Gas J.*, 13.1.45, **43** (36), 91–92.—The percentage yields of products, or fractions, obtainable from a crude may be assessed from the curves plotted from distillation data, and may be expressed in any suitable terms, such as vapour pressure, gravity, octane number, sulphur, etc.

Two convenient methods for their construction are described, and are illustrated by graphs from the tabulated data on the properties of fractions from distillation, and properties of blends: (*a*) the instantaneous, stream, differential or mid per cent data—*i.e.*, the property of the stream at any instant during the distillation; (*b*) the cumulative, yield, integral, or summation data representing the average properties of an accumulation of the distillate—*i.e.*, of a cut or fraction between two percentages of the crude oil.

The graphs are shown in the form of (*a*) mid per cent and yield evaluation curves; (*b*) isoproperty continuous curves, which show the yields on the ordinate and the mid per cent data along a 45° line.

Refiners Notebook No. 31 will also indicate the use of these curves under the title Realization. W. H. C.

## Distillation.

**64. Extractive and Azeotropic Distillation. I. Theoretical Aspects.** M. Benedict and L. C. Rubin. *Nat. Petrol. News Tech. Sect.*, 5.9.45, **37** (36), R.729.—Extractive and azeotropic distillation processes by which the separation of closely boiling hydrocarbons may be obtained, are defined and described. In both methods a solvent is added to increase the volatility between the key components, and the quantity added must be such that an appreciable concentration of the solvent exists in the liquid phase throughout the column. In azeotropic distillation the function of the solvent is to form a constant-boiling mixture with one or more of the key components, and it consequently forms part of the overhead distillate. In extractive distillation the solvent selected is less volatile than the key components of the mixture to be separated, and for effective separation must be added at the top of the column.

Applications of the two methods and examples are discussed and described, and flow diagrams are given showing the extractive distillation of a *n*-butane–butene mixture with acetone as the solvent, and the azeotropic distillation of mixtures of hydrocarbons, (1) with which the solvent is partially miscible with the overheads, and (2) with which the solvent is miscible with the overheads, and therefore requires additional facilities for separating the solvent from the overheads.

Graphical and algebraic methods are described for ascertaining the changes in concentration of the solvent and the components in the different sections of the system employed. In azeotropic distillation the distribution of the solvent is determined by the phase relationships in the mixtures of solvent and key components; in extractive distillation the distribution of the solvent throughout the column is determined by heat and charge input, as in a conventional absorber.

The main advantages of the two processes are:

Extractive distillation: (1) The heat input for a given separation is lower because the solvent is not distilled over; (2) a greater variety of solvents are available because the precise nature of phase relationships in mixtures of solvent and key components is not critical to the success of the process.

Azeotropic distillation: (1) When the proportion of overhead is small, less solvent is required; (2) in batch processes all the solvent required may be added to the system at the commencement of distillation. W. H. C.

**65. The Refiners Notebook. Stripper and Bottom Temperatures.** W. L. Nelson. *Oil Gas J.*, 21.7.45, **44** (11), 147.—With few exceptions, bottom temperature is dependent on the following: (*a*) inlet temperature to stripper; (*b*) self-cooling by evaporation; (*c*) heat losses through insulation; and (*d*) cooling by steam. Methods of calculating these are described and examples and graphs are given. T. M. B. M.

## Cracking.

**66. First 3-Coil Thermal Cracking Unit in U.S. Goes on Stream at Sunray Refinery.** Anon. *Nat. Petrol. News Tech. Sect.*, 5.9.45, **37** (36), R.676.—A brief account is given of the rebuilding of the original plants for topping and a one-coil Dubbs unit installed in 1934, to which in 1937 was added a second cracking coil, and recently a third furnace for thermal cracking, thus increasing the capacity from 4500 b/d to 7500 b/d. The revamped system now consists of heaters for heavy and intermediate feed-stocks operating at 900° and 920° F. and 600 and 500 psi, respectively. These streams join

as they enter the top of reactor No. 1, working at 300 psi, passing out from the bottom and joining the stream from the Light oil-furnace operating at 1020° F. and 500 psi on entering the top of reactor No. 2, which is operated at 250 psi. The stream from the bottom of reactor No. 2 is passed to a flash-chamber, operated at 105 psi, down which a stream of preheated crude oil flows over side-to-side trays for refluxing, a side stream from under the trays feeds the heavy oil-heating coil, and the bottoms flow out through an exchanger to heavy fuel-oil storage. The overheads pass on to the pressure distillate tower operated at 60 psi, entering low in the column, and pass through 4 bubble, 8 side-to-side, and 16 bubble trays to the overhead. A side stream is taken at mid-tower as the feed of the light oil coil and the residue from the bottom forms the feed of the intermediate heating coil. The overhead stream of pressure distillate preheats the crude stream serving as reflux in the flash-chamber before condensing, and is further processed in the stabilizing and polymer units. The flash-tower has the dual function of crude topping (preparing heavy cracking stock) and as a conventional flash-chamber, and the fractionator separates light and intermediate stocks for the other two cracking stocks and a pressure distillate as mentioned, the whole providing exceptional flexibility of operation and control through the use of the three heaters. The subsequent processing of the pressure distillate into fractions for the production of polymer gasoline, codimer, and straight-run naphtha, for aviation gasoline blending, is briefly described. The topping unit comprises two crude distilling columns and one furnace containing two separate coils, each processing 2500 b/d of crude oil. Each column produces 550 and 300 b/d and 300 and 275 b/d of gasoline and tractor distillate, respectively. The residuals (reduced crudes) are combined by passing through a heat-exchanger which preheats the oncoming crude to the second tower; the crude feed to the first tower is preheated in the base of the first tower. Each crude feed-stream is passed through a salt settler, after preheating, before entering the respective furnace. Operating data, net plant yields based on the charge of the two crudes processed and the properties of the stabilized pressure distillate are given. W. H. C.

**67. Cracking of Latin American Crude Oils. 7. Argentine Oils.** G. Egloff. *Oil Gas J.*, 13.1.45, **43** (36), 73.—Crude oils from the Comodore Rivadavia district vary in character from paraffinic to asphaltic base, their gravities range from 0·8708 to 1 at 60° F. The properties of, and distillation of typical Argentine oils (*a*) a light paraffinic crude, and (*b*) a mixed base crude, from the region noted are given. Two-coil cracking operations on the reduced crude (*a*) and on the whole crude (*b*) were made under the following conditions: (*a*) at 940° F. and 200 psi in the heavy coil, and 970° F. at 250 psi in the light coil, and under the same charging rates, to give 400° F., end-point gasoline and No. 6 A.S.T.M. fuel. The yields were 40·5% gasoline of A.S.T.M. octane rating 67, containing 0·04% sulphur; 53·9% residuum, and 5·6% loss. The cracked gases contained 11·9% propylene, 1·7% *iso*butane, and 4·0% *n*-butane, from which 2·8% polymer gasoline or 5·1% alkylates could be produced. (*b*) Three runs were made at slightly varying temperatures and about the same pressures; the relative charging rates were: (1) 3·05; (2) 3·19; (3) 2·21. The gasoline yields were 28·9%, 32·5%, and 36·3%, of A.S.T.M. octane values, 72, 72, and 71, respectively. Operation (3) gave gases containing 17·9% $C_4$ and higher olefins which would give 2·7% polymer gasoline, and the cracked residuum from this operation, 61·6%, had a Saybolt Furol viscosity at 122° F. of 272 sec. Gasoline from operation (2) was treated by sweetening and also by liquid-phase clay, after which the following results were obtained:

| Treatment | None | Sweetened | Liquid-phase clay |
|---|---|---|---|
| Reid vapour pressure, psi | 8·2 | 7·8 | 7·0 |
| Gum, copper dish, mgr/100 ml without inhibitor | 299 | 349 | 9 |
| With 0·025% No. 1 inhibitor | — | 236 | 8 |
| Induction period, minutes, without inhibitor | 110 | 85 | 240 |
| With 0·025% No 1 inhibitor | — | 145 | 450 |

Four runs were made on a topped highly paraffinic Comodoro Rivadavia crude in the two-coil unit, to produce gasoline of 392° F., E.P. and a fuel residue of varying gravities. The temperatures and pressures used were 920–950° F., at 150 psi heavy coil, and 960–970° F. and 300 psi light coil. The yields and product qualities are tabulated. All the gasolines had A.S.T.M. octane values of 69. Run No. 3 produced

52·2% gasoline, which had an end-point of 402° F. and a Reid vapour pressure of 9·8 psi, and 31·2% residuum of 169 seconds Saybolt Furol viscosity at 122° F., with a cold test of 55° F. and 16·6% gas and loss. The gasoline after the treatments stated gave the following results :

| | | | | |
|---|---|---|---|---|
| Acid, lb/brl | None | None | 1 | 4 |
| Sodium plumbite | None | 3 | 1 | 1 |
| Gum, copper dish, mg/100 ml without inhibitor | 154 | 189 | 12 | 1 |
| With 0·025% No. 1 inhibitor | — | 132 | 1 | 1 |
| With 0·05% No. 1 inhibitor | 60 | — | — | — |
| Induction period, minutes without inhibitor | 110 | 90 | 160 | 265 |
| With 0·025% No. 1 inhibitor | — | 160 | 450 | 890 |

The Sosneado crude from the Mendoza province is an asphaltic base oil. This crude was cracked in a single-coil unit at 941° F. and 151 psi to produce a 392° F. E.P. gasoline and a heavy residuum, and yielded 31·5% gasoline, 60·9% residue with 7·6% loss. The gasoline contained 0·27% sulphur and 164 mg/100 ml, gum; it had an octane value of 83. The residue had a Saybolt Furol Viscosity at 122° F. of 2594 sec. Treatment with 10 lb/brl acid gave a 7% loss and reduced the sulphur content to 0·16%, and gum content to 18 mgr/100 ml. Its octane value was 79. W. H. C.

## Chemical and Physical Refining.

**68. Russians Recover 90–95% of Sulphuric Acid from Sludge, Obtain Valuable By-products.** Anon. *Nat. Petrol. News Tech. Sect.*, 5.10.45, **37** (36), R.688.—The information contributed has been translated from various Russian literature published in 1938 and 1941–42, and shows that 90–95% can be reclaimed from acid sludge, and its concentration raised to 80% or higher by various processes. Valuable by-products, including naphthenic acids, sulpho-naphthenic acids, fuel oil, and sulphur dioxide, can be obtained from the organic portion of the sludge. Likhushin states that the organic material from a water-diluted sludge can be extracted by solvents, such as the residue from re-running pressure distillates, xylene, or dichlorethane. Pre-treatment of residual oils with sulphonic acids before treatment with sulphuric acid makes possible subsequent recovery from acid sludge of up to 81% of acid up to 30% strength, and leaves a fuel almost sulphur free. A Soviet patent of 1942 relates to an electrolytic method by which an acid of satisfactory colour is obtained from a sludge and is afterwards concentrated to 92% by evaporation. Acid sludge from the treatment of benzene and toulene from cracking operations has been used for refining xylene for over 13 years at one Russian refinery, and can be used as the first acid wash of benzene and toulene with a saving of 20–25% of fresh sulphuric acid. From the literature it appears that research is directed towards the production of drying oils, detergents, alcohols, demulsifying agents, and electrical insulating materials from acid sludge organic matter. W. H. C.

**69. *iso*Pentane Produced by Liquid-Phase Isomerisation.** L. S. Galstaum. *Chem. Met. Eng.*, 1945, **52**, 109.—Since the latter half of 1944 the Tide Water Associated Oil Co. has successfully operated a plant for the isomerization of pentane. The reaction, which is conducted on a contactor provided with efficient stirring equipment, is catalyzed by $AlCl_3$ dissolved in molten $SbCl_3$. HCl to the extent of 5 mol-% on the hydrocarbon feed, is also fed in with the catalyst. The reaction temperature is 200° F. and pressure 300 psi. $H_2$ representing a partial pressure of 60–70 psi is introduced into the system to suppress cracking. Above the level of the mixture in the contactor is situated a baffle above which the liquid is quiescent. Undissolved catalyst separates out from this layer in the form of a dense phase, and returns to the turbulent zone through slots in the baffle. In operation, a small amount of $AlCl_3$–hydrocarbon complex is produced. To prevent the accumulation of the latter a small volume of catalyst is continuously removed from the system and the $AlCl_3$ and $SbCl_3$ extracted from it by means of hot pentane feed, in a catalyst scrubber column. Reacted pentane mixture plus $H_2$ and HCl are separated from the $AlCl_3$–$SbCl_3$ solution by distillation, the latter being fed back to the system. HCl containing some hydrocarbon is next separated from the pentane in an HCl stripper (as a top product) and returned to the reactor, whilst the bottoms are cooled and soda-washed to yield the *iso*pentane. The

equipment in which pentane, catalyst complex, and HCl are handled together is constructed of C-steel, but in the contactor itself, in which turbulent conditions exist, the equipment must be Ni-clad. All valves in catalyst service are of Hastelloy trim.
L. B.

## Special Processes.

**70. British Research on Petroleum Substitutes. 8(2). Methane.** R. M. Bridgwater. *Petroleum*, Oct. 1945, **8** (10), 183.—The Lurgi process for gasifying lignite in steam and oxygen at 20 atm. yields a town's gas with a calorific value of 450–500 BTU. British coals gave a satisfactory product at 900–950° C., the yield depending on rate of heating, hydrogen rate, and total pressure. Both high- and low-temperature cokes gave similar yields under optimum conditions of hydrogenation temperatures. Researches conducted on a small-scale refractory lined steel tube heated in an electric furnace indicate that coal may be so hydrogenated so that just sufficient coke is left to be gasified in steam and oxygen to give a gas containing enough hydrogen to effect the hydrogenation. Methane has a calorific value 15% higher than Grade I petrol, and a very much higher octane number, but there are difficulties of the use of methane as a fuel in specially designed engines having compression ratios exceeding 10 : 1, one being the availability of supplies, and another in the method of storage of the gas, the weight of gas-cylinder equipment being considerable. However, the weight of container and liquid for liquid methane might amount to only 10–12 lb/equivalent gal of petrol, and this method of transport is suitable for vehicles in use for long periods each day. An Austin 4-cyl 12 hp van operated successfully on bottled gas containing 58% methane.
G. A. C.

**71. Fischer-Tropsch Commercial Process Announced by Kellogg.** A. L. Foster. *Oil Gas J.*, 13.1.45, **43** (36), 48.—The exploitation of the Fischer–Tropsch synthesis is possible according to an announcement made by M. W. Kellogg Co., who are in a position to provide plants necessary for the synthesis of hydrocarbon oils from carbon monoxide and hydrogen produced from the methane from natural gas by catalytic oxidation. It is stated that one of the major difficulties surmounted was the temperature control of the reaction, which is exothermic in character, and that motor gasoline obtained from the products of the synthesis has a clear octane rating of 75 A.S.T.M., and 83 by the research method, which by the addition of 1 cc lead tetraethyl is increased to 80 and 89, respectively. The yields are up to 80%, compared with European yields of 30–40% with octane values around 25. The cost is stated to be 5 cents/gal, on the basis that 1000 cu ft of gas costs 5 cents, with a plant depreciation of 10% per annum.
W. H. C.

**72. The Preparation of Olefines from Aldehydes and Ketones.** R. H. Griffiths. *J. Chem. Soc.*, 1945, 715.—Olefines may be prepared by passing the vapours of the corresponding aldehyde or ketone, together with excess hydrogen, over a molybdenum oxide catalyst at 400°. Both the temperature of catalyst and quantity of hydrogen must be controlled to ensure no further hydrogenation. The method has been found applicable in the preparation of styrene, heptene-1 and heptene-3.
B. H. K.

**73. Heat Deactivation of a Palladium Catalyst.** D. T. Gibson. *J. Chem. Soc.*, 1945, 713.—A heat-deactivated palladium–barium sulphate catalyst is described which has been used to hydrogenate ethynyl*cyclo*hexanol at atmospheric pressures to form the corresponding ethylenic alcohols in good yield.
B. H. K.

# PRODUCTS.

## Chemistry and Physics.

**74. Studies on Phosphorylation, Part II. Reaction of Dialkyl Phosphites with Polyhalogen-Compounds.** F. R. Atherton, H. T. Openshaw, and A. R. Todd. *J. Chem. Soc.*, 1945, 660.—A reaction of dibenzyl phosphite with strong amine in the presence of carbon tetrachloride, to form stable aminophosphonates, has been described. The

reaction has general application, and the carbon tetrachloride may be replaced by hexachlor- or pentachlorethane. Evidence indicates that, unlike trialkyl phosphites, which cannot be used under these conditions, dibenzyl phosphite has a co-ordinated phosphonate structure. B. H. K.

**75. The Present Era in Combustion.** D. T. A. Townend. *Chem. and Ind.*, 1945, **44**, 346–350.—This general survey of modern theories of combustion describes how industry may benefit from recent developments. It is indicated how heats of combustion could be used to calculate equilibrium constants using more accurate methods than provided by the Nernst equation. Factors determining slow combustion and spontaneous ignition, which had hitherto been little understood, were now becoming less obscure since the development of the new theory of chain reactions due to pioneer work of Semenoff and Hinshelwood. In a particular reaction activated species were at first considered to be energized molecules, but the discovery of photo sensitization led to the view that they were probably atoms or free radicles. The author further discussed variations of ignition temperature with pressure and the phenomena of cool flames, normal flames, and violent explosions with their corresponding inflammability ranges. Present theories of the spontaneous oxidation of coal postulated the formation of organic peroxides. Finally, mention is made of the luminescence phenomenon associated with refractory oxides under flame impact. G. P. K.

## Analysis and Testing.

**76. Gum Content of Distillate Diesel Fuels.** L. W. Dickey and R. Henry. *Ind. Eng. Chem.* (*Anal.*), **16** (11), 710–712; **Determination of Gum Content of Diesel Oils.** Anon. *Oil Gas J.*, 13.1.45, **43** (36), 84.—The procedure of the test is described; briefly it consists of measuring 25 ml of the sample into a 50 ml Erlenmeyer flask, and connecting it to a condenser and receiver. With the flask in an oil-bath, the sample is evaporated by a stream of inert gas at the rate of 250 ml per minute, under a reduced pressure of 50–55 mm mercury. The bath is maintained at such a temperature that the sample will be evaporated to dryness in $45 \pm 5$ min. This temperature will generally be 150° F. below the 90% point of the A.S.T.M. D.158 distillation method. After this period of heating the flow rate is increased to double, and the temperature is increased 50° F. for 10–15 min. The pressure is allowed to become normal, the flask is removed and 25 ml of a 50 : 50 mixture of carbon tetrachloride and acetone is added, and then evaporated off on a water-bath. The flask is again connected for vacuum operation on the oil-bath, under the same conditions for 15 min, after which it is removed, cleaned, dried, and weighed. Mg gum per 100 ml = Mg gain in weight × 4. By varying the temperature employed as defined, the pressure given is adequate for the evaporation, in about 1 hr, of samples varying in respect to their distillation range. The addition of the mixed solvents eliminates hold-up of evaporation due to "skin" formed by the gum, and secures reproducibility of results. An accelerated gum test very similar to the U.S. Government test for aviation fuel has been adopted by the authors. The test has given reproducibility with samples containing up to 1400 mg gum per 100 ml. W. H. C.

**77. Mercurous Perchlorate as a Volumetric Reagent for Iron.** W. Pugh. *J. Chem. Soc.*, 1945, 588.—The quantitative reduction of ferric thiocyanate to the colourless ferrous salt with mercurous perchlorate has been suggested as a volumetric procedure for the estimation of iron. Solutions of mercurous perchlorate reagent are found to be stable and the colour change at the end-point is sharp. Although results are said to be accurate for estimating high iron contents, no indication of the applicability of the method to determination of small quantities of iron is given. B. H. K.

## Lubricants.

**78. Lubrication Vade Mecum. 3(3). Alphabetical Index of Machines.** E. W. Steinitz. *Petroleum*, Sept. 1945, **8** (9), 178.—The alphabetical index of machines is completed in connection with the lubrication charts on classification of machinery and uses. G. A. C.

## Bitumen, Asphalt and Tar.

**79. Bitumen and the Bitumen Industry with Special Reference to Asphaltic Bitumen. 3(2). Properties and Composition.** J. S. Jackson. *Petroleum*, Aug. 1945, **8** (8), 150.—The discussion of some of the more important tests relating to the properties of bitumen, and their significance, is continued.

Indication of the composition is given by solubility in carbon disulphide, benzene, carbon tetrachloride (highly carbonaceous matter, impurities, etc.), and petroleum spirit (asphaltenes).

The Fraas breaking-point apparatus has been developed to test the behaviour of bitumen at low temperatures and determines the temperature at which a film of bitumen will crack on binding. The " Loss on Heating Test " gives a measure of the volatility of any bituminous product when heated for 5 hr at 163° C. in a specially designed oven; the test including the determination of the penetration after heating. Microscopic wax crystals have been observed in bitumens, but the amount normally occurring is quite small, and is determined by the Holde method, which involves destructive distillation.

Knowledge of the very complex composition of bitumen is limited, and methods of determination resolve themselves into breaking the product down into arbitrarily defined groups of hydrocarbons, such as asphaltenes, resins, and oils, a particular procedure being that of Strieter. A table is given with the Strieter analyses of some typical bitumens. Resinous bitumens, referred to as Albino bitumens, are usually light in colour.

Asphaltenes contribute both to the structure and hardness of bitumens, whilst asphaltic resins impart to the bitumen the characteristic property of ductility.

G. A. C.

**80. Bitumen and the Bitumen Industry, with Special Reference to Asphaltic Bitumen. 4(2). Asphaltic Bitumen in Road Construction.** J. S. Jackson. *Petroleum*, Oct. 1945, **8** (10), 190.—Cutbacks, spread at the rate of 6 sq yd to the gallon, followed by a dressing of dry, hard, tough chippings, are extensively used for the surface-dressing of roads under dry atmospheric conditions. The volatile flux quickly evaporates, the viscosity of the binder increasing, and, after rolling, a hard-wearing carpet is formed.

Using a cutback, or a soft grade of bitumen, as binder, thin chipping carpets are now constructed with a life equivalent to three or four surface dressings.

Control is essential for the success of these processes. Tests on portions of the finished road carpet indicate whether the correct amounts of the various constituents are present, and the properties of the constituents can be examined. The bitumen is recovered by a solvent such as carbon disulphide, and all traces of this must be removed after extraction, and apparatus has been devised to this end.

The development of bitumen emulsions enabled a " cold " process to be used. The "batch" method of preparation soon led to the use of a colloid mill for the continuous manufacture of the emulsion, the dispersion of the bitumen being mechanical. The emulsifier consisted of a soap prepared from such materials as liquid rosin, oleic, or naphthenic acids.

Specifications are in force for emulsions—for instance, the water content must not exceed 50% by weight.

These emulsions are stable in storage and transport, and resistant to frost, and little sedimentation occurs. They break readily when applied to the road surface, due to the rapid concentration of the emulsion as water is lost by evaporation. These labile (unstable) emulsions are easily applied, and the absence of heat treatment obviates any change in the properties of the bitumen. Bitumen emulsions can be adjusted to suit other forms of road construction, semi-stable and stable varieties being commercially obtainable.

G. A. C.

## Special Hydrocarbon Products.

**81. The Larvicidal Action of D.D.T. on *Anopheles quadrimaculatus*.** J. D. Maple. *J. Econ. Ent.*, Aug. 1945, **38** (4), 437.—It has been shown that D.D.T. acts on anopheline larvæ as a nerve poison disorganizing movement, so that they cannot retain contact with the water surface. Owing to the feeding habits of larvæ, D.D.T. is

generally ingested, but death also results from contact with D.D.T. solutions. Small quantities upset nervous equilibrium sufficiently to cause death by drowning, whereas with larger quantities fatal derangement of all nervous reactions takes place.
C. L. G.

**82. Larvicidal Aerosols Containing D.D.T.** H. A. Jones, C. C. Deonier, R. W. Burrell, and E. F. Knipling. *J. Econ. Ent.*, Aug. 1945, **38** (4), 432.—Laboratory and field tests on anopheline larvæ in water have been carried out with aerosols from D.D.T. in methyl chloride containing fatty acids. Application at the rate of 0·1 lb D.D.T. per acre to the surface of ponds gave nearly 100% larvæ control, a standard aerosol bomb containing pyrethrum and sesame oil in Freon 12 at a dosage of 0·2 lb of pyrethrins per acre gave only 62% kill. Complete control was obtained up to 60 ft from the point of release of the aerosol. It is considered that adaptation to application by air is particularly promising. C. L. G.

**83. D.D.T. Sprays Mechanically Dispersed for Control of Anopheline Mosquito Larvæ.** C. B. Wisecup, R. W. Burrell, and C. C. Deonier. *J. Econ. Ent.*, Aug. 1945, **38** (4), 435.—Owing to the small dosage of D.D.T. required for control of mosquito larvæ, application by conventional spray methods is not suitable. Tests have therefore been made with mists from paint-sprayer equipment and decontamination-type spray cylinders using solutions of D.D.T. in light solvents and in fuel oil No. 2. Using a power sprayer, 9½ quarts of a 5% solution of D.D.T. in fuel oil (at the rate of 0·15 lb D.D.T. per acre) gave complete control over a swamp area at a distance of 700 ft from the point of application. The prevailing wind is the limiting factor in applications of this type, variable winds reducing the distance controlled to 50–100 ft. If carefully applied, mechanically dispersed mists should be valuable for area treatments where complete coverage of small depressions and pools is difficult to obtain by local treatment.
C. L. G.

**84. Toxicity of Distempers Containing D.D.T.** S. Barnes. *J. Oil Col. Chem. Assoc.*, Sept. 1945, **28** (303), 181.—Toxicity tests have been carried out on house-flies and bed-bugs in contact with films of distemper containing varying percentages of D.D.T. It was found that a distemper film in which 0·4% D.D.T. had been incorporated after milling was more effective on bed-bugs than those in which the D.D.T. was added before milling, but the kills were much lower than in the case of flies. The addition of D.D.T. as large particles gave better results than when the ground product was added, and the toxicity was maintained for 6 months. It has also been shown that to obtain 100% kill on flies a dry D.D.T. deposit of 0·01 mg/sq cm from a kerosine solution is sufficient, whereas in a distemper 0·4 mg/sq cm is required. Similarly with bed-bugs, a deposit of 0·2 mg/sq cm from a kerosine solution is more effective than a deposit from a distemper containing 1·4 mg D.D.T./sq cm. C. L. G.

**85. Grub Control on Dairy Cattle in the North East.** J. G. Matthysse. *J. Econ. Ent.*, Aug. 1945, **38** (4), 442.—Excellent control of cattle grubs, particularly warble fly, was obtained with pyrophyllite-cube dusts, containing 1·05% rotenone, while wettable sulphur containing 2·1% rotenone gave lower control, possibly owing to poorer penetration of the latter into the cysts owing to its more hygroscopic nature. Two treatments are recommended, the first about 1 month before the cattle are turned out to pasture, and the second immediately before. Phenothioxine and yam bean gave little control. Spraying the legs of the cattle with D.D.T. solutions, emulsions, or suspensions was found of no value. C. L. G.

## Derived Chemical Products.

**86. Chemicals in War-time Germany.** Part 11. Anon. *Chem. Tr. J.*, 19.10.1945, **117**, 449.—Three plants produced 80,000 tons of synthetic fatty acids, and a fourth was under construction. The acids produced were utilized as follows: formic acid for treatment of fodder silos; acetic and butyric acids for esterification of cellulose; propionic acid, in the form of the calcium salt, as bread preservative; $C_5$–$C_9$ acids for production of alcohols for glyptal-type resins; $C_5$–$C_9$ acids for Foamite-type fire-

extinguishers; $C_9$–$C_{11}$ acids for mineral flotation; $C_{10}$–$C_{18}$ acids for soap production; $C_9$–$C_{16}$ acids for synthetic fats; $C_{18}$–$C_{24}$ acids in the form of salts for lubricating greases, softening agents for leather, and lubricants for plastic mouldings; and the pitch residues after ketonization and hydrogenation for petroleum-jelly substitutes.

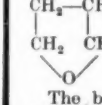
Methane from coke-oven gas was chlorinated to methyl and methylene chloride, chloroform, etc. Vinyl chloride and higher chloro-hydrocarbon derivatives were obtained from acetylene. 25,000–70,000 tons per annum of ethylene was produced from acetylene for ethylene oxide conversion to glycols or detergents of the Leonil, Genapol, or Igepon types. 500 tons per month of synthetic lubricating oil of viscosity 3–6° E. at 100° C. was produced from the polymerization of ethylene.

A number of synthetic insecticides were developed—*e.g.*, difluorodiphenyl trichloroethane (Gix), which was claimed to be more easily emulsified and more effective than D.D.T., though more expensive; phenylchlorophenyl trichloroethane; ω-chloromethyl-4-chlorophenyl sulphone (claimed to be more active than D.D.T. on lice and bugs, though less active on flies), a chlorinated derivative of ethyl chlorbenzene (Lucex—cheaper than D.D.T.); hexa-ethyl ester of tetraphosphoric acid (Bladan—a nicotine substitute); tetranitrocarbazole (Nirosan), and 1-sulphocyano-2 : 4-dinitrobenzene (fungicides); and polychloronitrobenzenes (as soil and seed disinfectants). Diethyl phthalate was used as mosquito repellent and a new product trichloro-acetylchloroethyl amide was being tested. Further moth-repellants of the eulan type—*e.g.*, triphenyl 3 : 4-dichlorophenyl phosphonium chloride—were developed.

A synthetic polymer, vinyl pyrrolidone (Periston), was used as a blood substitute for shock treatment, and new sulpha drugs developed. Higher alcohols were produced from lower aldehydes by condensation and hydrogenation, and used as lacquer solvents. Thiodiglycol for mustard-gas production was obtained from ethylene oxide and hydrogen sulphide in large quantities. Ketones were converted to diazoaminobenzene and azo-substituted compounds as additives for sponge-rubber compounding.

C. L. G.

**87. New Fields for Development Offered by Acetylene-Aldehyde Reaction.** Anon. *Chem. Industries*, Sept. 1945, **47** (3), 456.—The possibilities of the acetylene-aldehyde reaction, using metal acetylides as catalysts, are discussed, with particular reference to the production of butadiene, of which 20% of the German requirements were made by this method. The production of butadiene, as described by Dr. Reppe of the I.G. in 1940, consists in reacting acetylene with technical 30% formaldehyde producing first propargyl alcohol ($HO{-}CH_2{-}OH + HC{\equiv}CH \longrightarrow HO{-}CH_2{-}C{\equiv}CH + H_2O$) and then butyne 2 diol ($HO{-}CH_2{-}C{\equiv}CH + HO{-}CH_2{-}OH \longrightarrow HO{-}CH_2{-}C{\equiv}C{-}CH_2OH + H_2O$). The butyne 2 diol is then hydrogenated to butanediol $OH{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}OH$, which is dehydrated in two stops, first to tetrahydrofurane,



, and then to butadiene, $CH_2{=}CH{-}CH{=}CH_2$.

The basic reaction between acetylene and formaldehyde using metal acetylide catalysts is applicable to other aldehydes and ketones. Control of reaction conditions, in view of the danger of explosion from acetylene and copper acetylide, is very important, typical conditions being 3 atm at 100° C. and pH controlled to 2–7. By this reaction butynediol is produced as a 35% solution, the considerable heat of reaction being removed by evaporation of water, which is separated from unreacted acetylene by condensation and the acetylene recycled. Propargyl alcohol and methanol are removed by distillation. Hydrogenation of butynediol is carried out at 200 atm, using nickel catalyst. The butanediol is dehydrated quantitatively to tetrahydrofurane on heating with dilute phosphoric acid at 300° C. under 100 atm. The product is separated from water by distillation, and passed with water vapour over a catalyst at 260–280° C. to produce butadiene.

The availability of cheap propargyl alcohol by this process has led to its hydrogenation to allyl alcohol. Using the normal hydrogenation catalysts in acid medium, *n*-propanol is obtained, and in alkaline medium, propionaldehyde. By hydrogenation of the aldol followed by dehydration, *iso*prene is obtained. Propargyl alcohol is also readily converted to chlorallyl alcohols monomers for synthetic resins. Oxidation of butenediol in solution produces erythritol, used in alkyl resins, and in the vapour

phase, maleic acid. On dehydrogenation of butanediol over copper catalyst, γ-butyrolactone is produced, instead of succenic aldehyde, and this forms the basis of a large new synthetic field, including glutaric acid, piperidine, heavy metal phenoxybutyrates (used as driers) and *N*-vinyl pyrrolidone, used as monomer for synthetic resins, thickener, or adhesive. Tetrahydrofurane, besides being a valuable solvent for high polymers, can be converted to 1 : 4-dichlorobutane, from which hexamethylenediamine is obtained for conversion into polyamides. Reaction with ammonia produces pyridine and substitution products useful as anti-oxidants, pesticides, and vulcanization accelerators. Tetrahydrofurane may also be polymerized to rubbery or resinous products.

The basic reaction is applicable to acetaldehyde, which yields analogues of butadiene, and to higher aldehydes. Reaction of ketones and acetylene produces alkyneols, for which alkalis, alkaline-earth, or alcoholates are used as catalysts, instead of the metallic acetylides. C. L. G.

**88. B Methallyl Chloride as a Fumigant for Insects Infecting Stored Corn.** C. H. Richardson and H. H. Walkden. *J. Econ. Ent.*, Aug. 1945, **38** (4), 471.—Fumigation of stored corn with 12·5–16% B methallyl chloride solutions in carbon tetrachloride at the rate of 2 gal per 1000 bushels gave satisfactory control of red flour-beetle, saw-toothed grain-beetle and rice weevil without effecting germination of the wheat. The major impurity in B commercial methallyl chloride, *iso*crotyl chloride, is significantly less tonic, but there was no significant difference between the commercial and the pure grades. Carbon tetrachloride alone gave a lower control. With reasonable precautions, owing to the inflammability and toxicity, no ill effects should result from the use of B methallyl chloride. C. L. G.

**89. Propylene Dichloride for Peach-Tree Borer Control. Second Rept.** O. I. Snapp. *J. Econ. Ent.*, Aug. 1945, **38** (4), 419.—Tests over several years have shown that aqueous emulsions containing 9% of propylene dichloride applied to the soil around peach trees gives excellent control of peach-tree borer. There is no danger of damage to the bark, and the propylene dichloride is twice as effective as the ethylene dichloride previously tested. C. L. G.

## Miscellaneous Products.

**90. Plastics and Petroleum Work Together.** Part I. S. R. O'Dette and R. E. O'Dette. *Modern Plastics*, Oct. 1945, **23** (2), 142.—The part played by petroleum products—lubricants, hydraulic fluids, heat-exchange medium, and auxiliary process materials—in plastics production and processing will be surveyed in a series of articles, of which this serves as an introduction. The information is based on actual studies in factories, and includes recommendations made to obtain the best results. The factors influenced or controlled entirely by lubrication are listed, and will be discussed in detail later in relation to specific units of machinery. In the use of hydraulic fluids in the plastics industry particular problems are encountered, including excessive pump wear in hydraulic presses from ferrous oxide, plastic dust particles, sludges, and varnishes from the hydraulic fluid, and corrosion from water-soluble acids from oil decomposition. It is recommended that where possible only oxidation-resistant hydraulic oils containing corrosion preventatives should be used. If not possible, a 1 in 60 dilution of a soluble oil should be used. More attention should also be paid to filtration. For heat-exchange oils, modern practice is to use relatively light, highly refined oxidation-resistant oils instead of steam refined cylinder oils. These can be used in open systems at up to 350° F. and under pressure at up to 500° F. While oils can be used at higher temperatures for short periods, a heat-exchange fluid, such as Dowtherm, is advisable. For plastics mills and roll calenders of normal design operating at below 350° F., a lubricant of lower viscosity than the usual steam refined cylinder oils is preferred, but it should possess high oiliness and load-carrying properties. For rolls carrying temperatures of 550° F., or operating under refrigeration conditions, specially selected hydrocarbon lubricants will be required. The selection of suitable lubricating greases should not present any difficulty. The availability of rust preventatives should reduce problems in the protection of mould platens and machinery. The necessity of thorough purification of air used for cleaning mould surfaces requires the use of minimum

quantities of air-compressor lubricants, so that selection of the correct type is of great importance. C. L. G.

**91. Selective Weed Killers.** Anon. *Chem. Tr. J.*, 12.10.45, **117**, 401.—The development and large-scale testing of methoxone (Agroxone) as a selective weed killer are discussed. Investigations into the nature of plant hormones which control growth in nature led to the testing of naphthyl acetic acid for hastening the rooting of seedlings, preventing pre-harvest drop of apples, and producing seedless fruits. This was also found to prevent or retard seed germination and early growth of some weeds without affecting cereals. Of many related compounds produced, 4-chloro-2-methylphenoxy-acetic acid (methoxone) was found to be outstandingly active, the use of 8 oz per acre killing charlock, pennycress, and corn buttercup without damaging the cereal crop. The action is not yet understood, but absorpion into the plant or root arrests growth and causes distortion and splitting, finally resulting in death. Methoxone is non-poisonous, non-inflammable, and not unpleasant to handle. It is best applied as soon as the cereal is established. Further work is required to establish its use on pastures and lawns. Very extensive trials, covering 13,000 acres, have confirmed earlier results and established the particular weeds which can be controlled. These include the most important affecting cereal crops. C. L. G.

**92. Synthetic Rubber in Germany.** J. W. Livingstone. *Chem. Tr. J.*, 2.11.1945, **117**, 508; *Chem. Eng. News*, 25.9.1945, **23** (18), 162.—The total capacity of the German synthetic rubber industry amounted to 175,000 ton per annum, but of the 5 plants, 1 (Auschwitz) was never in operation, maximum total production being below 120,000 tons per annum. Production of butadiene from acetylene was more expensive than U.S. production from alcohol. Ethylene for styrene production was also derived from acetylene. The main types produced were Buna S and S3; these were too tough to be processed directly in Banbury mixers, and required heat softening before use. Tyres produced commercially from German Bunas were considered inferior to those from American GR-S. At the end of the war only smaller tyres were made from Buna S3, high proportions of natural rubber being used in the larger sizes. Inner tubes made earlier in the war from Buna SS were unsatisfactory, and those produced later from a mixture of Bunas and natural rubber were not entirely satisfactory. Only experimental quantities of polymers of the butyl or neoprene types were produced, the latter mainly for cements and other special uses. C. L. G.

**93. Silicone Rubber.** Anon. *Chem. Industries*, Sept. 1945, **47** (3), 474.—Dow Corning Corpn have announced the commercial availability of Silastic, a silicone rubber produced in various stocks for moulding, extruding, coating, and laminating. The rubber remains elastic after heating to 500° F. and is flexible at −70° F. It is also highly resistant to oil and brine at high temperatures, and has excellent electrical properties. C. L. G.

**94. Cellulose Propionate.** Anon. *Chem. Tr. J.*, 2.11.45, **117**, 500.—The Celanese Plastics Corpn of Bishop, Texas, announces the development of a new plastic, Forticel, which will be in large-scale production in 1947. Propionic acid is obtained from natural gas in commercial quantities and at reasonable prices by a process that has been developed. Cellulose propionate is claimed to have a greater toughness and higher impact strength than any other cellulose ester. It is thermoplastic, odourless, easily coloured and printed, and the finished products from injection or extrusion moulding display unusual surface lustre and brilliant finish without mechanical polishing. C. L. G.

**95. Polyvinylidene Chloride.** J. Taylor. *Brit. Plastics*, Dec. 1945, **17** (199), 490.—A review is given of the manufacture of polyvinylidene chloride, the forms in which it is used and their application. Commercial production began in the U.S. in 1939, the monomer being produced from trichloroethane by reacting with aqueous alkaline earth hydroxides under heat. If pure and free from oxygen, vinylidene chloride polymerizes very slowly, but in the presence of oxygen, as with the usual benzoyl peroxide catalyst, acid chlorides are formed which catalyse the polymerisation. The monomer is frequently co-polymerized with, *e.g.* vinyl, styrene, or acrylic derivatives. The polyvinylidene chloride may be moulded by compression, injection, or extrusion, and is available in the form of moulding powder, films, filaments, or tubing. The

standard grade has a softening point of 115–140° C., and the mouldings from it are resistant to acids and alkalis, except concentrated ammonium hydroxide, and to most solvents, except dioxane and *cyclo*hexanone, whilst it is softened by chlorinated hydrocarbons. In processing, care must be taken to avoid contact with iron at high temperatures, which causes decomposition, and to allow for its low thermal conductivity. In the U.S. it is available in a wide range of sizes of piping and tubing of excellent flexibility and solvent resistance. Extruded filaments have been made up into highly wear resistant upholstery fabrics, window-screens, etc. Sheets are used for anti-corrosion tank linings, and new semi-soluble types of polyvinylidene chloride show promise in the coating of textiles, paper, leather, and metals. It has also been produced as a transparent film, useful for packaging. C. L. G.

## Engines and Automotive Equipment.

**96. Bearing Development up to Date.** H. Luetkemeyer. *Nat. Petrol. News Tech. Sect.*, 5.9.45, **37** (36), R.718.—Despite the immense advancements in science and in the types of prime moving engines, with enormously increased power and speeds, and requiring greater resistance to wear and improved design in bearings, Babbitt's selection of a bearing alloy, 106 years ago, still remains as an example of the basic characteristics with but very little change. In general, bearing life is characterized by three qualities: (*a*) resistance to fatigue; (*b*) surface action; (*c*) corrosion or wear. These fundamentals are analysed and discussed—the extremes of fatigue resistance are those on Babbitt's metal and electroplated silver; surface action is affected by hardness, machinability, weldability, imbeddability, and wettability; corrosion or wear is generally a combination of chemical and mechanical removal of bearing surface, but either may occur separately. Failure or partial failure of a bearing surface attributable to these three qualities is shown by photographs of bearings and journals. The following bearing metals are described and discussed: white metal alloys; cadmium base alloys; copper–lead base alloys; aluminium; silver, and silver with a layer of indium-treated lead, analogous to the early tri-metal construction of steel with an intermediate layer of leaded bronze and a surface layer of tin-base alloy; powdered metals in which recent progress has been made by their use in the form of a trimetal construction—*i.e.*, an intermediate layer of powdered metal between steel and a working surface of some soft, cast, or plated bearing metal. Trimetal and micro bearings are discussed, the construction of the former entails many difficulties, but precision plating of layers appears to offer a solution. The bonding of alloys to steel, etc., and the Kolene process are outlined, the latter permits the bonding of tin and lead base alloys to cast iron, and is a distinct advance, particularly for diesel engine bearings. Bearing loads (the maximum load in lb/sq. in, based on the projected area) of some of the alloys are shown in a table, grouped under various vehicles, aircraft, and diesel engines; and analyses of the bearing alloys are given. Oil grooving is considered and illustrated, elaborate grooves have been displaced by simpler forms which maintain a maximum bearing area. Testing technique is discussed; the Chevrolet test gives constructive help; the Underwood bearing testing machine is being used for studying surface action, and has given satisfactory results for this purpose, as well as for fatigue testing. Some important observations on design are included. W. H. C.

**97. First U.S. Gas Turbine Demonstrated.** J. H. Kunkel. *Petrol. Engr*, Sept. 1945, **16** (13), 98.—The first large gas turbine built in the United States for continuous service is described. This turbine is the first to be used for ship propulsion. It burns 47 lb per hp hr of No. 2 distillate, develops 2500 useful hp, weighs and occupies 30 lb and 3·5 cu ft per hp respectively.

The units comprise a high- and a low-pressure combustion chamber, high- and low-pressure compressors, high- and low-pressure turbine, a regenerator and intercooler to give maximum theoretical efficiency of 32·5% with an actual efficiency of 29%.

The low-pressure compressor takes in free air and compresses it to a pressure of 43 lbs per sq in absolute at a temperature of 300° F., which latter is reduced by a water cooled intercooler to about 90° F. before passage into the high-pressure compressor, where its pressure is increased to 96 lb per sq in absolute, and the temperature to about 280° F.

In the high-pressure combustion chamber, "spitter" injected fuel oil is burned

directly in this air stream, reaching a temperature of 1230° F. at the entrance to the high-pressure turbine, where expansion provides power to drive the low-pressure compressor. In the low-pressure combustion chamber, the air from the high-pressure turbine exhaust is reheated to about 1200° F., and then expanded in the low-pressure turbine to develop 5000 hp, half of which is used by the high-pressure compressor, the remaining 2500 hp being available power.

The combustion chamber is a simple right angle in a pipe-line, operates at a maximum pressure drop and can cover a wide range of load without burner replacement.

The use of streamline and nesting tubes decreases the pressure drop and increases the surface density for a given size of tubing. "Creep" phenomenon in construction material when under load, demanded careful choice of the materials and loadings; for example, a special grade of nickel that could be spun was produced for the torroidal joints. Welding is extensively used, and new electrodes were developed.

Steel shafts were used in the Elliot-Lysholm compressors, the joint between rotor and shaft being made by low temperature brazing. Temperature expansion problems presented difficulties, and special methods were employed to prevent free conduct of heat to undesired locations. These included the use of heat dams and oil and air cooling at bearings and pin rings. A special colloidal compound was devised for the threads of nuts and bolts to enable the machine to be dismantled after operation.

The gas turbine has future applications in mobile power plants and a number of reaction turbines have been successfully employed in catalytic cracking units.

G. A. C.

## MISCELLANEOUS.

**98. United Kingdom Petroleum Trade 1938–44.** Anon. *Petrol. Times*, 1945, **49**, 692.—Detailed information is given regarding the amount and value of petroleum products imported by the United Kingdom during the war period, although direct imports by the Armed Forces are not included in the figures quoted.

Import figures are listed for the years 1935–44, classified into: (*a*) crude oil; (*b*) motor spirit; (*c*) spirit other than (*b*); (*d*) kerosine; (*e*) lubricating oil; (*f*) gas oil; (*g*) fuel oil; and (*h*) other products. Imports for paraffin wax, asphaltic bitumen, and bituminous emulsions are given for the years 1938–44. The effect of war on imports is also illustrated graphically.

Total imports of petroleum into the United Kingdom during 1944 reached a figure of 5,560,787,000 Imp. gal an increase of 39·1% over 1943 and 73·6% over 1938. The corresponding value at £222,192,319 was 44·7% higher than in 1943 and an increase of 383·2% on the 1938 value. The far greater increase in the 1944 figure as against 1938 is for gas oil, which has almost quadrupled in the period, with a rise of 291·3%. In the case of motor spirit and fuel oil, the increases are 99·2 and 94·5%, respectively. Kerosine and lubricating oil imports were reasonably steady, with a slight upward trend. Crude oil declined steadily until 1944, when it showed a 28·9% increase over the 1938 figure. Paraffin wax increased in quantity and value during the middle war years, but later declined in quantity to less than the pre-war figure. Asphalt and bitumen declined until, in 1943, imports were less than one-sixth of the 1938 imports. Bitumen emulsions declined almost to vanishing point.

C.i.f. values of United Kingdom imports in pence per Imp gal, for crude petroleum and refined products are also given from 1919 to 1944, and shown in graphical form. These figures show that all refined petroleum products had their c.i.f. values more than doubled in 1944 as against 1938, while that for crude oil was trebled. For paraffin wax and natural asphalt the values were more than doubled during the same period, while for bituminous asphalt and emulsions it was nearly quadrupled. T. M. B. M.

# BOOKS RECEIVED.

**Industrial Toxicology.** By D. Hunter. Pp. 80. Oxford, 1944. 10*s.*

The Croonian Lectures for 1942 of the Royal College of Physicians of London. A detailed review, with bibliography and index, of the effects of toxic substances encountered in industry.

**Reference Books of Inorganic Chemistry.** By Wendell M. Latimer, Prof. of Chemistry, University of California and Joel H. Hildebrand, Prof. of Chemistry, University of California. The Macmillan Co., New York, revised edition, 1940, reprinted 1944.

This is a revised edition of a book first published December 1928, and is as the title implies, essentially a reference book. It has been brought up-to-date in so far as development in atomic, molecular, and crystal structure, bond energies, etc., are concerned. Is intended as a reference book for students to aid in the reading of chemical literature.

**The Chemistry of Organic Compounds.** J. B. Conant. Pp. 680 + x. Revised edition, 1939. The Macmillan Co., New York.

"The chemistry of organic compounds" presents material covering a year's course. While including much that is characteristic of elementary textbooks an attempt is made to give some indication of new advances in biological chemistry, and the application of physical chemistry to the study of organic reactions.

**High-Speed Diesel Engines.** By A. W. Judge. 4th Edition, reprinted and enlarged. Chapman and Hall, London, 1945, 25*s.* net.

This book of 525 pages deals in fourteen chapters with all types of high-speed compression-ignition engines, including cylinder-head design, fuel injection systems, fuels and supercharging. About 100 pages of up-to-date information has been added to the 1941 edition.

# ABSTRACTS.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# Oilfield Exploration and Exploitation.

## Geology.

**99. Geological Surveys are Planned for Continental Shelf.** Anon. *World Petrol.*, Nov. 1945, **16** (12), 65.—After the introduction of new legislation in U.S.A. the Geological Survey has been asked to make recommendations for a survey of the submerged area of the continental shelf, an area exceeding 750,000 sq ml. Seismic surveys can be made, and magnetic surveys are possible by means of aeroplanes. Submarines could carry out gravimetric surveys.

The three most promising areas are the Coast of the Gulf of Mexico, the Pacific Coast, and the Alaskan region.

The shelf is taken as the area with not more than 600 ft of water. Its width varies widely. Off the U.S. coast in the Gulf of Mexico the area involved is 149,000 sq ml.

G. D. H.

**100. Pre-Pennsylvanian Stratigraphy of Western Nebraska.** G. S. Dille. *Oil Wkly*, 22.10.45, **119** (8), 45.—There is, in western Nebraska, a broad anticlinal axis running N.W.–S.E. (Barton Arch or Cambridge Anticline, expressed in Cretaceous and younger rocks). Along this trend a few deep holes have encountered granite, and this granite shows two highs, one in Sheridan County and the other in Lincoln and Dawson Counties. Other highs may be present. The granite outcrop in pre-Pennsylvanian times was 75 ml wide in the Hyannis area of Grant County, narrowing possibly to 20 ml at the Kansas border. The outcrop may have been very broad in Cherry and Sheridan Counties, possibly linking with the schists of Bassett County. The Salina Basin of Kansas may run into Nebraska, but it is not known how far north this will extend as a syncline with pre-Pennsylvanian beds. Mississippian beds occur in the area of Franklin, Webster, and Kearney Counties, but are absent in a well in Valley County. The greatest thickness of Mississippian (310 ft) was recorded in Webster County. Below the Pennsylvanian, Kinderhook beds have not yet been found, but Viola-Galena beds occur. A few wells have logged Simpson, and the Arbuckle and Deadwood have been encountered in the southern part of the State.

The pre-Pennsylvanian Salina Basin extension is not believed to be of great depth, and rises northwards.

On the west and southwestern flank of the granite axis it is believed that all the Kansas formations of pre-Pennsylvanian age will ultimately be found, except the Hunton and Kinderhook.

Over the granite axis only the Kansas City-Lansing and the conglomerate at the base of the Pennsylvanian are thought to have a chance of producing oil. The Cambrian, Arbuckle, Viola-Galena, and the Mississippi lime are all potential oil reservoirs, provided local trapping structures exist.

A tentative map shows the inferred structure of the top of the granite, and the pre-Pennsylvanian outcrops of west-central Nebraska. G. D. H.

**101. Shell Oil Activity Spreads in Colombia.** Anon. *Oil Gas J.*, 6.10.45, **44** (22), 82.—The Casabe field produces 9000 brl/day from 29 wells. The 21·5°-gravity oil is found at 3700–3900 ft in a relatively low-pressure reservoir. Present development is on 40-acre spacing. A well drilled to 6089 ft showed deeper possibilities of producing 24°-gravity oil in a zone which may be comparable with one of the prolific zones of the De Mares area.

In the Lower Magdalena Valley, about 100 ml from Barranquilla, potential production of 2750 brl/day of 42–46°-gravity oil has been established by five wells on the El Dificil concession. The first well on test gave 54 brl of oil and 700,000 cu ft of gas/day. All the wells produce from a limestone in the Upper Oligocene, at an average depth of 5800 ft.

In the Llanos region 1 San Martin was abandoned at 3120 ft because of mechanical trouble. A second well has reached 5800 ft. There are unconfirmed rumours of an important oil discovery. 1 Chafurray, also in the Llanos region, was abandoned at 1750 ft. G. D. H.

**102. Nova Scotia Wildcat Drilling below 6000 ft.** Anon. *Oil Gas J.*, 6.10.45, **44** (22), 82.—A wildcat south of Amherst, Cumberland County, Nova Scotia, has reached a depth of 6000 ft. It is 50 ml southwest across Northumberland Strait from the Hillsborough Bay test. G. D. H.

**103. Devonian Deposits found near Krasnokamsk, Russia.** Anon. *Oil Wkly*, 22.10.45, **119** (8), 66.—An 1100-brl well is reported to have opened up a rich Devonian oil accumulation (Severokamsk) at a depth of 5840 ft near Krasnokamsk. Two wells have been completed in Daghestan at 5000 ft. G. D. H.

## Geophysics and Geochemical Prospecting.

**104. Newer Phases in Geochemical Technique.** A. Bronston. *Oil Wkly*, 29.10.45, **119** (9), 56.—Soil samples were taken at depths ranging 5–150 ft, making sure that they were quite free from vegetable matter. At least three sets of samples were taken from each hole at different depths. Wax determinations showed fair consistency of values from 10 to 50 ft, but there was a marked decrease in deeper samples. The amounts ranged 30–7000 parts per million. The type of wax was determined. The observations on samples from depths less than 10 ft below the surface could not be used to give usable pictures for solid hydrocarbons. Haloes were obtained in most instances by using at least two samples from each hole.

The most accurate method of determining gaseous hydrocarbons in the soil consists of collecting the gas directly from the hole. Gaseous hydrocarbons in the soil range 10–1000 parts per 1000 million by weight. The hydrocarbon content of the gas is determined by combustion after removal of $CO_2$. Gaseous soil hydrocarbons may also be determined colorimetrically.

Liquid hydrocarbons are more consistent in soil samples than are the waxes and gases. They range 1000–10,000 parts per million by weight, and when taken at depths free from vegetable matter increase in quantity with depth. The quantity was determined in a special distillation apparatus. The hydrocarbon type is of value in determining the source. Shallow fields should give greater concentrations than deeper fields. Some holes give low-gravity oils from the first 25 ft, and high-gravity oils deeper. Shallow oil seems to give a comparatively large accumulation of hydrocarbons directly over the reservoir rather than around the edges, although a similar condition has been observed with deep oil where there is no definite geological structure—*e.g.*, West Edmond. On faulted structures with a concentration of hydrocarbons round the edges there is a marked concentration of both liquid and gaseous hydrocarbons along the downthrown side of the fault and a negligible quantity on the upthrown side (Heidelberg).

Where an oil reservoir exists the percentage of hydrogen in the soil at depths of 50–100 ft is practically identical with that of methane. From drilling wells there is a marked decrease in percentage of hydrogen with depth. G. D. H.

## Drilling.

**105. Drilling Equipment Needs.** D. Ragland. *Oil Wkly*, 12.11.45, **119** (11), 70.—A brief study is presented of the cost of drilling and of time analysis of drilling operations, including coring, cementing, testing, etc. On the basis of this study, several necessary improvements are pointed out. A. H. N.

**106. New Ideco Mechanical Rig.** C. H. Engelmöhr. *Petrol. World*, Nov. 1945, **42** (11), 71.—The mechanical rig described is designed for 10,000-ft drilling. The Ideco Powerhoist M-10,000 is powered by three General Motors Twins, which are

unique in that they combine the power output of two six-cylinder diesels through a single output shaft. The power units turn at 1600 rpm; the output shaft at 900 rpm. The engines are rated at just short of 300 hp at the above speed for intermittent service. Each engine is equipped with Kittell air-cooled silencers. Some loss of horsepower is experienced in the reduction and in the compounding transmission drives. An Ideco 7500-Q chain-driven transmission is built integrally with the hoist unit, which enables the operator to change locations with one less package than most competitive rigs. This feature notwithstanding, all packages are within road width limitations imposed by many States. Details of the transmission gear and other accessories are given. A. H. N.

**107. Rig Mounted on Wheels.** H. A. Hess. *Oil Wkly*, 15.10.45, **119** (7), 36–41.—Various units of the rig, which is capable of drilling to 7500 ft, are mounted on four semi-trailers. One of the trailers carries the diesel-electric power unit, another the mud-pump assembly, another the derrick and draw-works, and the other the fuel tank. The derrick floor, substructure, rotary table, and blowout preventer comprise another unit. However, this unit is not mounted on wheels, but is erected on skids for easy portability. The drill-pipe, of course, is moved on a regular pipe-truck, the remainder of the equipment, tools and miscellaneous items, are carried by trucks or trailers. This arrangement permits quick dismantling, moving, and erection. Disconnection of a few connecting pipes, electric wires, or other items, and the various units are ready to be towed to the next location. Furthermore, the tractor used in towing the units to their next site is not tied up during drilling operations. Another feature of the layout is the use of jacks to take the load off the trailer tyres during drilling operations. Several photographs illustrate details of the rig. A. H. N.

**108. Rock Bits.** J. B. Isaacs. *Petrol. World*, Oct. 1945, **42** (10), 53.—Rock bits are found to be the best types to use in California drilling. Different types are discussed, with their special characteristics. A. H. N.

**109. Lubrication on the Drilling Rig.** J. R. Schones. *Petrol. World*, Oct. 1945, **42** (10), 62.—Lubrication of rubbing surfaces on the drilling rig is discussed. A. H. N.

**110. Field Installation of Slush-Pump Piston-Rod Lubricators.** H. A. Hess. *Oil Wkly*, 12.11.45, **119** (11), 68–69.—Photographs illustrate several methods of lubricating the slush-pump piston-rod. Lubrication with oil is advised as the crew appear to pay more attention to such lubricators than to water systems. A. H. N.

**111. Carnotite in Squeeze Cementing.** A. J. Teplitz and W. E. Hassebroek. *Oil Wkly*, 29.10.45, **119** (9), 41–45.—The results of several experiments and tests using carnotite as a tracer are described. In spite of the limitations of the method, the use of carnotite as a radioactive tracer is extending the knowledge of physical processes taking place underground during squeeze cementing and other cementing operations. While such information is of interest in itself, its principal value lies in the application to the technique of petroleum production. In conjunction with caliper, electrical, and temperature surveys, radioactive tracing will often indicate the course taken by the cement outside the casing. Although each well presents an individual problem, it is possible that when sufficient data of this type have been obtained, generalizations may be drawn which will enable operators to select most favourable pressure for a particular squeeze job. The possibility is also envisioned that with the knowledge gained, the placement of the original casing cement may be so modified that the necessity for squeezing will be considerably reduced. A. H. N.

**112. Valuable New Tables on Cement Slurry Formulas.** Anon. *Oil Wkly*, 15.10.45, **119** (7), 46–48.—Capacity of hole, capacity of pipe, hydrostatic pressures of fluids at various depths, annular space between casing and hole, annular space between tubing and casing, annular space between casings, displacement of pipe and formulas for cement slurry are presented. These tables are taken from a handbook shortly to be published by "Universal Atlas Cement Company." A. H. N.

## Production.

**113. Application of Oil-Field Water to Geology and Production.** L. C. Case. *Oil Wkly*, 29.10.45, **119** (9), 48.—The principles of oil-field analyses and interpretation are discussed. The applications of water analyses to the study of production in connection with bottom-hole water, to problems of spent acid, to drilling mud or cement waters, and to identification of extraneous waters entering wells are discussed in some detail. Significance of water analysis in calculations connected with water-flooding and salt-water disposal is also discussed in some detail. The interpretation of water analysis in connection with geology forms the latter part of the paper. A. H. N.

**114. Volumetric and Phase Behaviour of Oil and Gas from Paloma Field.** R. H. Olds, B. H. Sage, and W. N. Lacey. *Petrol. Tech.*, May 1945, **8** (3), *A.I.M.M.E. Tech. Pub.* No. 1861, 1–21.—Samples of liquid and gas were taken from the primary separator of a well in the Paloma field. The volumetric properties of the samples and of six systematically chosen mixtures of the samples were experimentally determined at 100°, 190°, and 250° F., at pressures up to 5000 lb/sq in. From these data the influence of pressure and temperature on the composition and specific volume of the bubble-point liquid and of the retrograde dew-point gas was established. The formation volumes and gas/oil ratios of the mixtures investigated were calculated on the basis of the plant-product oil, which is defined as the *iso*butane and less volatile portion of each mixture. The results are presented in graphical and tabular form.

The volumetric behaviour of the mixture corresponding to that produced by the well at the time of sampling was determined for 235° F., the reported reservoir temperature, by graphical interpolation of the experimental data with respect to composition and temperature. The results indicate that the well-production mixture probably existed as a gas at its retrograde dew-point under the conditions of temperature and pressure believed to prevail in the producing zone at the time of sampling.

The effect on the phase behaviour occasioned by the omission from the well-production mixture of certain components of intermediate molecular weight was investigated. In the first case, all of the *iso*butane and *n*-butane, and substantially all of the *iso*-pentane, were removed from the mixture of trap samples corresponding to the well production. In the second case, all of the propane, *iso*butane, and *n*-butane, and substantially all of the *iso*pentane were removed. Both modifications led to considerable increases in the retrograde dew-point pressure at 235° F., an increase of 558 lb/sq in above that of the unmodified well-production mixture in the first case, and an increase of 1208 lb/sq in in the second. Accordingly, it was concluded that the materials remaining after the removal of certain components of intermediate molecular weight could not be re-injected into the reservoir in the same proportion in which they were produced without entailing appreciable loss of liquid material through condensation within the formation. G. D. H.

**115. Back-Pressure Open-Flow Computations Simplified.** W. F. Martin. *Petrol. Engr*, Nov. 1945, **17** (2), 152.—Charts are reproduced from *Petroleum Engineer's* Continuous Tables, which were designed to facilitate computing changes in open-flow occurring because of changes in rock pressure. The charts are explained.

A. H. N.

**116. Average Gas-Oil Ratio of Nation's Oilfields.** K. M. Fagin. *Petrol. Engr*, Nov. 1945, **17** (2), 51.—A brief discussion of the elements of the different types of drives and its influence on gas/oil ratios is given. The average gas/oil ratios of different States is given graphically, and each State is discussed separately. The estimated average gas/oil ratio of all the oil-wells in the U.S.A. was 1278 cu ft/brl during 1944, compared with 1109 cu ft/brl during 1937. Although this is a ratio increase of only 169 cu ft/brl during the eight-year period, the total gas produced from oil-wells increased from 1,419,830 million cu ft to 2,144,720 million cu ft, representing a total gain of 724,890 million cu ft. The large gain in the total volume, therefore, is mainly due to increased oil production rather than to increased gas/oil ratio. This may be interpreted by some as indicating an improvement in the conservation of gas, inasmuch as many of the newer, deeper oilfields have higher gas/oil ratios than the older, shallower oilfields, but the ratios of the oil-wells in some of the individual States increase from year to year.

The ratios in other States decrease, and most State ratio curves fluctuate considerably. The reasons for these variations may be many. Some of the reductions in the gas/oil ratios of some of the States are probably due to actual reductions resulting from a reduction in the gas/oil ratio limits, or the introduction of more pressure maintenance, or better compliance with the rules, but a large part of the apparent reduction in the gas/oil ratio in some of the States is probably due to a reclassification of oil-wells to gas-wells or gas-condensate wells, or more oil production from low-ratio water-drive fields. A. H. N.

**117. Elements of Gas-Lift Practices.** L. P. Connor. *Petrol. Engr*, Nov. 1945, **17** (2), 127.—The general principles of continuous and intermittent gas-lift operations are discussed. Typical test data and worked examples are given. A. H. N.

**118. Mobile Unit to Service Paraffined Wells.** W. J. Davis. *Petrol. Engr*, Nov. 1945, **17** (2), 220.—A truck is fitted with equipment necessary for cleaning wells. A 4-hp gasoline engine drives the No. 10 winch by V-belt drive. An outboard bearing carries an extension of the winch shaft, which has a 9-in crank welded to it. This gives an 18-in throw to the spudding attachment used in connection with the winch-drum. An ½-in soft-laid steel line is used to lower the tools into the hole. The rear of the pick-up has a frame constructed of old sucker rod on which scaffold boards can be placed in order to aid the operator in making connections on wells with tall christmas trees. Photographs illustrate the use of the unit. A. H. N.

**119. Opening Clogged Screens with Explosives.** D. D. Kinley. *Oil Wkly*, 5.11.45, **119** (10), 42.—The shot consists of a series of bakelite cups, 4–6 in long and slightly over 1 in in diameter, mounted on ½-in aluminium pipe and spaced equidistant on this pipe. These cups are filled with 100% strength gelatin. The amount of explosive is varied somewhat, depending on the well conditions, such as height of fluid column, nature of fluid, and purpose of shot. This variance is regulated by the length and number of the cups used. The aluminium pipe is filled with blasting caps opposite the charges of gelatin connected by primacord fuse, which is a detonating agent in itself. A spring guide is placed on the aluminium pipe every 6 ft, to centre the charge in the screen. The top of the aluminium pipe is connected to a firing gun which contains a blasting-cap with a primer inserted, devised so that a rod through the centre of the gun will strike the primer, setting off the initial blasting-cap, which in turn detonates the shot below it. Two types of firing guns are used, depending on whether the charge is to be set off by a drop weight or by jar action. In the first case the steel line on which the shot is lowered is passed through a disc at the top of the gun, which is connected to the firing-rod. A weight dropped over the line strikes the disc and moves the rod, setting off the primer cap. In the second case the gun is equipped with a device which enables it to land in a casing collar or in the top of a liner, and the firing-rod is actuated by a set of jars above the gun, operated by manipulating the steel measuring line at the surface after the gun is set in the collar.

The use of the shot for cleaning is described. A. H. N.

**120. Use of Electrolytic Models.** H. G. Botset. *Oil Wkly*, 26.11.45, **119** (13), 33.—The operation of the electrolytic model is based on the fact that if two electrical terminals, one positive and one negative, are placed in a conducting liquid (ionized salt solution), the current flowing between the electrodes will be carried by the ions of the salt. These ions represent the fluid particle in the oil or gas reservoir, and the water in which they are dissolved represents the porous sodium or reservoir rock. By making the dissolving medium gelatinous by the addition of agar-agar, the mechanical diffusion of the conducting ions is reduced to a very small magnitude, and essentially the only motion of the ions in the medium is that resulting from the electrical gradient. By the use of the proper salts, coloured ions are produced so that their motion in the electrical field may be visually observed and photographed. In the electrolytic model two salt solutions are used, one for the output wells and the porous medium, and the other for the input wells. It is desirable to be able to see the ions representing the input fluid; therefore, these are coloured, while the others are colourless. The two salts generally used in the electrolytic model are zinc–ammonium chloride and copper–ammonium chloride. The copper–ammonium

ions are deep blue in colour, while the chloride and the zinc–ammonium ions are colourless. The detailed construction of a typical model is discussed and typical results are reproduced. A. H. N.

**121. Water Permeability of Reservoir Sands.** N. Johnston and C. M. Beeson. *Petrol. Tech.*, May 1945, **8** (3), *A.I.M.M.E. Tech. Pub.* No. 1871, 1–12.—For many years the permeability of reservoir sands has been measured by passing air through a cleaned and dried core sample. Such a measurement differs from the true reservoir permeability in one important respect: in the reservoir the rock particles are surrounded by interstitial water, not air, and their physical shape and state of hydration are greatly dependent thereon. Permeability as defined must be measured with a single phase fluid. No means exist for removing the oil and gas from a core sample by simply flowing water through it; the sample must be cleaned and then re-saturated with water before testing. After such a cleaning process a considerably different permeability value is obtained with salt or fresh water from that for air. On re-wetting after drying, particles may swell and break down, and even migrate. The ratio of air permeability to salt-water permeability ranged from 3300 or more down to one, while the ratio of the fresh-water permeability to the salt-water permeability ranged from zero to one.

When the salinity of the water flowing was varied, some cores showed a rapid permeability decline even at high salinities; other samples maintained a high water permeability down to low salinities. The data indicate that the amount, distribution, and properties of the clay or other affected solids in the sand must vary over a considerable range in many reservoirs.

It is suggested that the salt-water permeability is probably closer to the true reservoir permeability than is the measurement with air. Possibly the application of such measurements will improve the empirical relationship between specific productivity index and permeability, but so far the average air/salt-water permeability ratio for over 1200 cores does not show a large enough value to account for the entire deviation from the theoretical relationship. G. D. H.

**122. Behaviour of Water-Input Wells.** Part 2. P. A. Dickey and K. H. Andresen. *Oil Wkly*, 26.11.45, **119** (13), 46.—It is important to be able to tell, as the intake rate declines in the early stages of injection, whether the decline is due to plugging of the sand, and therefore remedial, or to the fill-up of the reservoir, and therefore irremedial. What is required, therefore, is a method of determining the intake capacity of the well itself without regard to the conductivity of the whole system surrounding it. Such tests could be made periodically on certain selected wells scattered over a flood, and a close check on the efficiency of the input wells could be maintained. It is believed that an entirely practical method of determining the efficiency of an input well is determination of its localized injectivity index. Injectivity index is the reverse of productivity index, a concept that has proved of value in the study of the efficiency of producing wells. Injectivity index is defined as "the number of brl/day of gross liquid injected into a well/lb/sq in pressure differential between mean injection pressure and mean formation depth." In order to be most useful, in studying the behaviour of individual input wells this concept should be restricted to define the conductivity of the individual well, and not the general conductivity of the whole system—*i.e.*, it should not be affected by the whole area of sand surrounding the well and the productivity indices of the adjacent producing wells. It should be the determination of the conductivity of a cylinder of sand surrounding the well, in which cylinder most of the pressure drop takes place, and whole inside wall is the sand face—which is apt to become clogged by impurities in the injected water. This restricted index will be called the "localized injectivity index."

These concepts are discussed together with mathematical derivation of the injectivity index A. H. N.

**123. Factors Affecting Lateral Vibration of Walking Beams with Beam Counterbalance.** K. N. Mills. *Oil Wkly*, 22.10.45, **119** (8), 36–39.—One of the most discussed theoretical disadvantages of beam counterbalance on a pumping unit is the possibility of a walking beam or samson post failure due to lateral vibration of the walking beam. The results of this investigation indicate that dangerous lateral vibrations cannot be

induced in the beam of a properly designed beam counterbalance pumping unit. They also indicate that the samson post is the least rigid member in the system, and, therefore, the rigidity of the samson post should be high. When numerical values are substituted in the equation for the moment of inertia of the beam weights, it will be found that the largest contributing factor to their inertia is distance from their centre of gravity to the centre line of the samson post. As increasing the value of the moment of inertia of the system lowers its natural frequency, it is desirable to locate these weights as near the samson post as is economically practical.

A. H. N.

**124. Miniature Oilfield Foretells Production.** Anon. *Petrol. Engr*, Nov. 1945, **17** (2), 216.—The model recently discussed by H. G. Botset is described. See Abstract No. 120. A. H. N.

**125. Two Veteran Oil-Wells.** E. Adams. *Petrol. Engr*, Nov. 1945, **17** (2), 100.—A search for the oldest producing oil-well has uncovered some interesting side-lights of the beginnings of the oil industry and found, still in comparative obscurity, two oil-wells whose history almost spans that of the U.S.A. oil industry. Right to the title of " Oldest Producer in the World " is claimed for each of the two veteran wells. This record is not easily checked in the U.S.A., and is even more difficult to verify for the world. Several months of inquiry have uncovered no other well with as strong basis for its claim. The closing of the old wells, however, must come before the record for " longest period of production " can be determined for either well. One of the producers was drilled not far from the Drake Well on Oil Creek, Pa, Aug. 1861. It was then known as the Colby well, and has since been renamed the McClintock No. 1. The other octagenarian is less than 200 miles away in southeastern Ohio. It is the Old Buell No. 1, at the edge of Macksburg near Duck Creek. The well takes its name from the first owner, Barnum Buell, who with George Dunlevy completed it in 1862 or 1863. The obscurity of the date is not surprising considering the length of time required for drilling in those days. The Drake was started in 1858 and completed in Aug. 1859. The history of the two wells is given.

A. H. N.

**126. Patents on Drilling and Production.**—H. Allen, assr to Cameron Iron Works. U.S.P. 2,380,388, 31.7.45. Appl. 21.10.40. Well-head and casing suspension structure.

G. L. Hassler, assr to Shell Development Co. U.S.P. 2,380,520, 31.7.45. Appl. 24.4.42. Borehole indicating apparatus.

H. J. Quintrell, assr to Lane-Wells Co. U.S.P. 2,380,612. Appl. 25.2.42. Tubing anchor and packer assembly.

W. G. Eris, assr to The Texas Co. U.S.P. 2,380,639, 31.7.45. Appl. 16.9.43. Production of oil.

L. D. Mowrey. U.S.P. 2,380,669, 31.7.45. Appl. 11.3.43. Well anchor.

E. B. Williams. U.S.P. 2,381,415, 7.8.45. Appl. 19.11.43. Drill bit.

J. C. Stokes, assr to Reed Roller Bit Co. U.S.P. 2,381,844, 7.8.45. Appl. 11.5.42. Core-taking apparatus.

J. C. Stokes, assr to Reed Roller Bit Co. U.S.P. 2,381,845, 7.8.45. Appl. 11.5.42. Pressure core-drilling apparatus.

C. M. Bryant, assr to Dow Chemical Co. U.S.P. 2,381,875, 14.8.45. Appl. 19.9.41. Apparatus for treating wells.

D. G. C. Hare, assr, by mesne assignments to The Texas Co. U.S.P. 2,381,904, 14.8.45. Appl. 16.10.41. Method and apparatus for logging wells.

M. Schlumberger. U.S.P. 2,381,929, 14.8.45. Appl. 1.8.41. Well-conditioning apparatus.

J. T. Phipps, assr to M. O. Johnston Oil Field Service Corpn. U.S.P. 2,382,094, 14.8.45. Appl. 7.1.42. Hook-wall well-packer.

A. Wolf and G. Herzog, assr to The Texas Co. U.S.P. 2,382,279, 14.8.45. Appl. 27.11.43. Device for recovering a radiation source.

J. W. Johnson. U.S.P. 2,382,422, 14.8.45. Appl. 3.2.43. Sucker-rod connection.

G. F. Turechik, assr to Lane-Wells Co. U.S.P. 2,382,455, 14.8.45. Appl. 20.1.42. Bridging plug.

F. E. Frey, assr to Phillips Petroleum Co. U.S.P. 2,382,471, 14.8.45. Appl. 3.3.41. Method of recovering hydrocarbons.

A. J. Penick. U.S.P. 2,382,578, 14.8.45. Appl. 8.6.43. Producing equipment for wells.

E. N. Washburn, assr to Phillips Petroleum Co. U.S.P. 2,382,685, 14.8.45. Appl. 14.7.41. Rotary jet gun.

E. Koppl and F. W. Harris, assr to Patco Inc. U.S.P. 2,382,725, 14.8.45. Appl. 9.12.42. Rotary underreamer.

D. E. Batchelder, assr to Lane-Wells Co. U.S.P. 2,382,770, 14.8.45. Appl. 3.3.42. Setting tool for bridging plugs.

J. A. Zublin. U.S.P. 2,382,933, 14.8.45. Appl. 16.12.41. Method of drilling holes.

A. L. Prout, assr of one half to B. Pugsley, and one half to M. A. Campbell. U.S.P. 2,383,214, 21.8.45. Appl. 18.5.43. Well casing expander.

E. D. Garrett, assr to The Brewster Co. Inc. U.S.P. 2,383,248, 21.8.45. Appl. 25.10.41. Combination tubing head and tubing support.

C. S. Crickmer. U.S.P. 2,383,453, 28.8.45. Appl. 29.6.42. Anchoring device.

H. G. Abadie, assr of one half to F. G. Bradbury. U.S.P. 2,383,455, 28.8.45. Appl. 28.11.42. Method and apparatus for locating leaks in wells.

J. G. Bouslog. U.S.P. 2,383,844, 28.8.45. Appl. 2.11.42. Oilwell bailer line measuring device.

W. S. Crake, assr to Shell Development Co. U.S.P. 2,383,934, 4.9.45. Appl. 1.8.44. Oil-well pump.

L. Hartsell. U.S.P. 2,384,090, 4.9.45. Appl. 20.10.44. Well tool.

D. Johnston. U.S.P. 2,384,173, 4.9.45. Appl. 27.10.43. Deep well pump.

H. C. Otis and J. C. Luccous, said Luccous assr to said Otis. U.S.P. 2,384,192, 4.9.45. Appl. 26.8.40. Well packer and apparatus for producing wells.

J. P. Walker, assr of 40% to G. O. Marchant and 6% to C. G. Wells. U.S.P. 2,384,222, 4.9.45. Appl. 28.4.41. Method of and means for desalting petroleum well fluids.

A. H. Nailson. U.S.P. 2,384,331, 4.9.45. Appl. 8.2.45. Insert for sucker-rod elevators.

S. Krasnow and L. F. Curtiss, assr to Geophysical Development Corpn. U.S.P. 2,384,840, 18.9.45. Appl. 16.4.37. Radioactive well logging method and apparatus.

M. Muskat, assr to Gulf Research & Development Co. U.S.P. 2,385,298, 18.9.45. Appl. 16.10.41. Recovery of oil from oilfields.

R. O. Walton, assr to Merla Tool Corpn. U.S.P. 2,385,316, 18.9.45. Appl. 9.6.44. Well-flow device.

R. G. Piety, assr to Phillips Petroleum Co. U.S.P. 2,385,378, 25.9.45. Appl. 11.6.42. Well surveying. G. F. W.

## Oilfield Development.

**127. Construction Programme Under Way in Iraq will Triple Present Crude Output.** C. O. Willson. *Oil Gas J.*, 10.11.45, **44** (27), 60.—A 16-in 620-ml pipeline from Kirkuk to Haifa is planned. This will run parallel with the existing 12-in pipeline. A similar

line may be built to Tripoli, and both should have a capacity initially of 100,000 brl/day. Kirkuk has produced 280,000,000 brl since 1934, and can maintain an output of 300,000 brl/day for many years. It has been classed as the world's largest single reservoir.

Interest in Iraq existed before 1914, and the Iraq Petroleum Co. commenced exploration in 1925. In 1927 the 1 Baba Gurgur gusher was completed at 1521 ft, near the crest of the Kirkuk structure, and near oil and gas seeps. The two 12-in pipelines began to carry crude in 1934. In 1936 a three-unit crude stabilization plant was built in the field to combine gasoline recovery with removal of $H_2S$ and fixed gases. The Haifa refinery had an original capacity of 30,000 brl/day, but was enlarged to 90,000 brl/day.

Before the war 55 wells had been drilled in the field, which is 65 ml long and averages 2 ml wide. These included observation wells. All but 6 were plugged and permanently abandoned as a war measure. When normal production became possible again 5 wells met the pipeline capacity.

The uppermost beds at Kirkuk are sands, gravels, and conglomerates. Below the Upper Fars consists of sand, siltstone, and shale, and the Lower Fars of siltstone, anhydrite beds with minor limestones, and an anhydrite-limestone series. These rest on the main producing limestone. The producing porous limestone is extensively fissured, giving long-distance communication between wells. It is of Oligocene and Upper Eocene age. The surface structure does not conform with that of the reservoir. Wells are drilled on a contour pattern. It has been found that a well can produce as much as 20,000 brl/day without disturbing reservoir conditions. The bottom-hole pressure is always kept above the bubble-point, maintaining liquid-phase conditions in the reservoir, and giving substantially the same gas/oil ratio in all wells.

Because of plugging, redrilling has been necessary. Ten wells are now capable of producing, and the present programme calls for a total of 20, which will give an output of 400,000 brl/day.

The wells are fitted with controls and have calibration charts which facilitate adjustments of output. They are drilled by the rotary method. No lining or tubing is used.

A large reserve of low-gravity high-sulphur content oil has been established at Qaiyarah, but the oil is not at present refinable, and no plans have been made for its development. A small Cretaceous structure has been discovered at Ain Zalah. The field is not fully defined. Its crude is similar to that of Kirkuk. A major reserve has been discovered on the Qatar Peninsula, less than 100 ml from Bahrein and Dammam. Two producing wells have been drilled to depths of 5000–6000 ft. G. D. H.

**128. Five Fields with 51 Wells in Iran Produce Total of 365,000 Brl of Crude Daily.** C. O. Willson. *Oil Gas J.*, 6.10.45, **44** (22), 74.—The discovery well at Masjid-i-Sulaiman was completed in 1908. Initial development was on close spacing. A well, F-7, was completed in 1911 for 1000 brl/day, but in 1914 its production rose to 7000 brl/day. When mudded off in 1926 it had given over 50,000,000 brl, making it the world's largest well until two wells at Haft Kel exceeded this figure.

Production is from the Asmari limestone in southwest Iran. The upper 500 ft of this formation at Masjid-i-Sulaiman consists of thick-bedded foraminiferal limestones; the lower part includes marls and anhydrite. The limestone is mostly of low porosity, but folding has created fissures, and only where fissures occur is there commercial production under present practices. Some early fissures are filled with calcite and anhydrite. The overlying Lower Fars differs considerably in structure from the Asmari, which outcrops and gives seeps not far from Masjid-i-Sulaiman.

Production of oil causes the gas–oil level to fall and the oil–water level to rise less quickly. Development practice gives water-free crude with a minimum gas/oil ratio, the gas being wholly solution gas. Efforts are made to maintain horizontal gas–oil and water–oil surfaces as far as permeability and other conditions allow. Reservoir fluid levels and pressures are carefully observed by periodical measurements in indicator wells.

Except at Masjid-i-Sulaiman all the active fields employ multi-stage stabilization of the crude. At Gach Saran the equipment is controlled from a central point, and the crude then flows 166 ml to the refinery through a 12-in pipe. Wherever possible the stabilizing plant is situated so as to allow gravity flow. The stabilizing equipment is briefly described. At present Gach Saran is producing 40,000 brl/day from three

active wells. This structure is only partly defined, and may be the largest yet discovered in Iran.

In 1939 the re-injection of part of the crude-oil fraction was begun at Masjid-i-Sulaiman to secure an operating balance between supply and demand. The fraction is obtained from a local topping plant, and provision has been made for the return of surplus products from the Abadan refineries. After injection the heavier oils settle to just above the water level. This process saves overground storage.

At Agha Jari special precautions are needed in drilling to combat heaving formations and high pressures. On drilling into the reservoir mud losses indicate the presence of producing fissures. Then drilling is stopped and swabbing or bailing undertaken to initiate oil flow.

The extent of the present producing formations has been determined in only three of the existing fields. Masjid-i-Sulaiman is said to have reserves exceeding 70,000,000 brl in an area 18 by 3½ ml. A similar area is involved at Agha Jari, while Haft Kel is 20 by 3 ml. G. D. H.

**129. Pemex has Active Drilling Programme.** Anon. *Oil Wkly*, 12.11.45, **119** (11), 62.—The Tampico embayment is the most important of Mexico's proven oil provinces, having produced 85% of the total oil, and possessing a similar percentage of the known reserves. The Isthmus–Tabasco area is next in importance. No oil production has been found in northern Mexico, but the similarity of conditions to those of South Mexico make such discovery likely. Northern Mexico has three gas fields.

Seventeen geological parties are working in Northeast Mexico, the Tampico-Tuxpan embayment, the Isthmus-Tabasco area, and Lower California. Geophysical work is under way in a number of areas, and includes seismic and gravity investigations. G. D. H.

**130. Completion Rate Rises.** Anon. *Oil Wkly*, 22.10.45, **119** (8), 51.—During Sept. U.S. well completions averaged 543/week, compared with 502/week in Aug. and 558/week in July. The figure for Sept. 1941, was 716/week.

19,079 wells have been completed in the first nine months of 1945, 9% more than in the corresponding period of 1944. There are indications that the 1945 total will be about 25,500 wells.

A table summarizes the completion results for Sept., by States and districts, and gives totals for Aug. 1945, and Sept. 1944. The cumulative completions for the first nine months of 1945 are analysed, and rig and footage figures are given. G. D. H.

**131. An Engineering Study of the Lafitte Oil-Field.** H. Vance. *Petrol. Tech.*, May 1945, **8** (3), *A.I.M.M.E. Tech. Pub.* No. 1869, 1–15.—The Lafitte field, South Louisiana's largest oil reserve, is in Jefferson Parish, some 25 ml due south of New Orleans. The discovery well was completed in May 1935, for 960 brl/day of 34·9° A.P.I. oil from 9558 to 9572 ft. 3–8 wells have been drilled per year, giving 60 producers and 3 dry holes at the beginning of 1944. Wells are drilled by steam-driven rotaries mounted on submergible barges, floated into position along a canal dug to the location. After completion the barge is refloated and taken to a new location.

The structure is an elongated dome broken into three segments by two north-south faults. The west segment is highest and contains most oil and gas. There are five main producing sands, two having no gas cap. These sands lie 8045–10,070 ft deep, and average 28–52 ft in thickness. Up to the beginning of 1944 35,662,264 brl of oil and 39,285,054 million cu ft of gas had been produced. Porosities and permeabilities are probably high. The pressure in each sand is maintained by natural water encroachment, although in the early history of the deepest sand the operation was under gas drive.

A salt intrusion is probably responsible for the uplift, but no salt has been found yet. Contour maps are given for each sand, and also reservoir performance diagrams. G. D. H.

## Transport and Storage.

**132. Zinc Anodes for Preventing Corrosion of Distribution Mains.** C. L. Morgan. *Petrol. Engr*, Sept. 1945, **16** (13), 196.—Experiences with the use of zinc anodes to prevent corrosion to certain steel gas distribution mains in Houston, U.S.A., are given.

Frequent leaks due to soil corrosion on steel welded 6- and 10-in poorly coated gas mains cost $2500 to find and repair in 1941.

The mains were divided into 100-ft electrically insulated sections for the provision of cathodic protection to each. After exploratory experiments, a 99·9% pure zinc plate ½ by 3 by 36 in and weighing 14 lb was selected as the anode, costing, after preparation for installation, $2.15 each. The section of main was completely insulated from all metallic structures, such as the house piping, and steel pipe from cast-iron pipe.

Tests using a 6-volt storage battery as a source of current were made to determine the current required to protect the section for a 15-year period. Approximately 15 plates operating at 15 milliamperes per plate were required to maintain 1000 ft of well-insulated 6⅝ in O.D. steel treated pipe at 0·85 volt with reference to $CuSO_4$ electrode after the pipe had polarized; and generally more zinc than was required was installed.

Five zinc plates were installed in a vertical stack in fairly low resistance soil, with the top plate deep enough so as not to be affected by seasonal drying out of the soil; at depths not exceeding 20 ft, and the backfill mixtures carefully selected.

Complete records of data on all conditions and factors influencing the performance of zinc were obtained, and frequent observations made. It is estimated that the average cost of protecting a mile of 6-in pipe was $2000. Protection to all mains in the business section of Houston was completed early in 1944, and only only leak has been found up to July 1945. There was an average of 19 corrosion leaks in 1941, 1942, and 1943.

Performance of the zinc has been satisfactory, the zinc potential has not lowered materially, and efficiency has been found to be 90%. A table shows weight loss and current efficiency data of test plates removed. Further work has shown that bare lines are most difficult to protect; well-coated ones require very little current. Other metals and alloys are being tested as current sources. G. A. C.

**133. Graphic Solutions of Design Problems. 5. Resistance of Fittings.** P. Buthod and B. W. Whiteley. *Oil Gas J.*, 17.10.45, **44** (28), 286.—This article deals with the calculation of pressure differences in pipes. The various factors which affect the difference in pressure between inlet and outlet sections of the pipe are listed as: (i) difference in elevation; (ii) gain or loss of kinetic energy of the fluid; (iii) mechanical work added or taken from the fluid; (iv) frictional losses in the fluid system, consisting of friction loss in the straight pipe, enlargement and contraction losses, and resistance of fittings, meters, orifice plates, etc.

Of these, (iv) is usually of the major importance, and a method is given of calculating the resistance to flow afforded by various fittings in terms of an equivalent of straight pipe. Within the viscous flow region, the resistance is primarily a function of the Reynolds number, but in the turbulent region of flow the resistance of fittings is independent of the Reynolds number, and the experimental values for equivalent lengths may be used with reasonable accuracy for such viscous fluids as oils.

The equivalent lengths of various types of fittings are shown plotted against pipe diameter, and in order to calculate pressure loss in a line, the equivalent length of all fittings in the system is added to the length of straight pipe.

Methods of calculation and examples are given. T. M. B. M.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**134. Distinguishing Features of Refinery Centrifugal Pumps.** J. Taylor. *Petrol. Times*, 24.11.45, **49** (1261), 989.—The differences between centrifugal refinery pumps and those used for other purposes are discussed in the light of the more severe duties they are called upon to perform. The auxiliaries installed with refinery pumps are described and the reasons for their provision and future trends of design are discussed.

The duties for centrifugal refining pumps as compared with most other pump applications involve variable combinations of high pressures and temperatures, lighter specific gravities, and low values of net positive suction head over vapour pressures of liquid handled. "Suction" pressures of 450 psi or higher, with discharge as high as 2100 psi, and temperatures up to 800° F. are common. Most refinery pumps have vertically split casings with circular joints to allow for high temperatures and pressures,

and light liquids; and are centre line-mounted to eliminate misalignment between pump and driver resulting from expansion when handling hot liquids. Pressure influences choice between cast and forged steel for construction materials, and temperature between cast iron and cast steel. Forged steel is used for combination of pressures above 1200 psi and temperatures above 600° F. Cast iron is used for other extremes below 200 psi and 200° F. Practical limits for cast-iron casings would be 300 psi and 300° F. The inside of forged-steel cylindrical case-barrels is lined with a welded layer of stainless steel to prevent corrosion; and rubbing parts are suitably hardened. There are several minor differences, such as wearing rings on both sides of impellor in a single-stage " process-type " pump. Auxiliary piping is liberally used for distributing cooling water, supplying gland oil and lubricant, and for bleeding off liquid to reduce the pressure. Packing boxes require a piping to arrange for difficult conditions.

As flow in modern refineries must be continuous, stand-by pumps must be installed. Fire is a great hazard, hence motors and electrical equipment are made explosion-proof, and insulating jackets and lagging provided on hot pumps and lines to protect personnel as well as conserve heat.

Vertical pumps offer a saving, and speeds higher than 4000 rpm are likely in the future. G. A. C.

**135.* Determination of Pressure Fluctuations on the Simultaneous Operation of Centrifugal and Ram Pumps Connected in Series.** I. A. Charnui. *Bull. Acad. Sci. U.R.S.S., Cl. Sci. Tech.*, 1945, 491–496.—In order to increase the speed of operation of a ram pump, a scheme has been worked out whereby a centrifugal pump feeds into the suction line of the former. A mathematical analysis is presented of the pressure fluctuations in the suction side of the ram pump for two cases: (*a*) direct connection of the pumps by means of a line; and (*b*) connection by means of an intermediate air chamber. V. B.

**136. Pressure Vessel Design Calculations.** S. M. Jorgensen. *Refiner*, Oct. 1945, **24** (10), 381—385.—Formulæ and graphs are presented for stress and strain calculations in high-pressure plants. Vacuum vessels designs are also studied quantitatively. A. H. N.

**137. Analysis Determines Control Variables for Distillation Systems.** C. W. Perry. *Chem. Met. Eng.*, 1945, **52**, 108.—The purpose of the paper is to clarify Gilliland and Reed's rigorous analysis of the degrees of freedom for multicomponent, multistage, interphase contact systems. The treatment is based on Gibbs' Phase Rule, as well as on the fundamental laws of matter and energy, and special attention is paid to the application of the method to practical problems encountered in automatic control. Systems considered are: (1) single-stage non-condensing still; (2) single-stage condensing still; (3) rectifying columns with boiler and total condenser. The practical examples of stabilizer control and alcohol-still operation are discussed in some detail. L. B.

**138. Slide Rule Conversion for Manometer Readings.** M. E. Klecka. *Chem. Met. Eng.*, 1945, **52**, 127.—In the measurement of flow of water, a mercury differential manometer set across an orifice plate in the line is frequently used, and the differential pressure read in inches mercury. This may be rapidly expressed in terms of feet water, by setting 21 on the C scale of a slide rule opposite 22 on the D scale. Then inches mercury set on the C scale will give the corrected pressure drop in feet water on the D scale. L. B.

**139. Determining Pump Discharge by Height of Stream from Vertical Open-End Pipe.** F. C. Bennett. *Chem. Met. Eng.*, 1945, **52**, 126.—The characteristic discharge curve of a pump may be determined by allowing it to discharge through a pipe which is straight for 40 diameters and then rises vertically. The end of the pipe must not be submerged. A fountain is produced, and θ, the quantity of water discharged, in gals per minute, is related to $D$, the pipe diameter in inches and $S$, the height of fountain in feet, by the equation $\theta = 19{\cdot}6\,CD^2\sqrt{S}$. If the pump discharges through a section of pipe, $C = 0{\cdot}98$. If a sharp-edged orifice is used at the exit, $C = 0{\cdot}63$. L. B.

**140. Use of Cast Iron in Chemical and Process Industries.** F. L. La Que. *Nat. Petrol. News Tech. Sect.*, 3.10.45, **37** (40), R. 806.—The metallographic structure of grey cast iron is briefly discussed in relation to corrosion resistance, and extensive data are recorded of the corrosion rate of cast iron and austenitic cast iron (Ni-resist) in contact with materials used in the petroleum and chemical processing industries. Factors dictating the choice of cast iron for use when corrosive materials are employed are discussed, and reference made to the increased resistance to corrosion by the addition of nickel or nickel and copper, and large amounts of silicon. Ni-resist contains about 20% nickel or nickel and copper in the ratio of 2 : 5 Ni to 1 of Cu. An English alloy, "Nicrosilal," contains approximately 18% Ni, 6% silicon, and 2% chromium; both are austenitic alloys suitable for use up to 1500° F, where small permanent dimensional changes may be tolerated; and in the petroleum industry are used for tube supports, crude-oil distillates, acid and acid sludge, valves and fittings, pumps and pump liners, condenser sections, meters, etc. For services where the casting may be subject to abrupt and considerable changes in temperature, which lead to high thermal stresses, up to 30% nickel gives much lower coefficient of thermal expansion; the minimum thermal expansion is attained with about 35% Ni. Particularly corrosive materials—*e.g.*, cold and hot $H_2SO_4$, with or without oxidizing compounds present, $HNO_3$,$H_3PO_4$ organic acids and acid salts, require an alloy with about 14·5% silicon. Tabulations are given showing type of alloys useful for pumps and valves used with corrosive gases and liquids in refineries. W. H. C.

**141. Metallizing Refinery Flash Towers.** L. V. Hils. *Refiner*, Oct. 1945, **24** (10), 386–387.—Metallizing with aluminium resulted in longer periods between shutdowns and more economical working. A. H. N.

**142. 90,000-Barrel Haifa Refinery Largest in Mediterranean Area.** C. O. Willson, *Oil Gas J.*, 17.10.45, **44** (28), 160.—A description is given of the 90,000-brl plant of Consolidated Refineries, Ltd. (jointly owned by Anglo-Iranian and Anglo-Saxon). located at Haifa. The Iraq Petroleum Co. produces 85,000 brl/day of crude from the Kirkuk field, half of which is sent to Tripoli, Lebanon, and the other half to Haifa, constructional work on this site being commenced in 1938 for the processing of this crude.

The first 29,000-brl unit consisted of crude oil topping, wax cracking, and viscosity breaking of the residual product, and a second unit of the same design and capacity was completed in 1941. Reforming units for reforming the heavy gasoline cut from the crude oil topping were built, but have never been operated. The course of the war necessitated changes in original design before completion of the second combination unit, however, as it was considered that the plant should be operated to maximum yield of liquid products, and operating changes were therefore made in the combination units to distil and fractionate additional crude. The viscosity breaking unit was altered to produce an asphalt cut, and a plant was installed to process solid and cutback bitumens from the asphalt fraction.

The installation of a third 28,800-brl crude oil distillation unit was completed in Aug. 1944, which had the effect of increasing the crude oil capacity to 85,000–90,000 brl daily.

The distillation of the stabilized Iraq crude is 45° C I.B.P. with 30% distilling to 187° C, 50% to 287° C, and 70% to 400° C, and the main products at Haifa at the present time are 80 O.N. motor gasoline, special naphtha, kerosine, gas oil, diesel fuels, fuel oil, bitumen, and butane gas.

The refinery operates its own sulphuric-acid manufacturing plant, producing 30 tons per day of 98% acid, using the contact process with vanadium pentoxide catalyst.

A flow diagram of refinery operations is included and a full description of these is given. T. M. B. M.

## Distillation.

**143. Equilibrium Flash Vaporization Correlation of ASTM and High Pressure Curves.** J. Griswold and M. E. Klecka. *Refiner*, Oct. 1945, **24** (10), 388–393.—Relations between ASTM and equilibrium flash vaporization curves are reviewed, and a dependable correlation is presented for slope of the flash curve at superatmospheric pressures. A. H. N.

**144. Refiners Notebook. Side Reflux.** W. L. Nelson. *Oil Gas J.*, 18.8.45, **44** (15), 155.—Side reflux is defined and its advantages and disadvantages discussed. The method of calculation of side-reflux heat is given together with examples.

T. M. B. M.

## Cracking.

**145. Small-Scale Catalytic Cracking.** H. D. Nell and V. O. Bowles. *Refiner*, Oct. 1945, **24** (10), 373–380.—Small-scale Thermofor Catalytic Cracking plants are discussed and operational data discussed. The studies presented in this paper lead to a number of interesting and practical conclusions : (1) TCC is now available for the small refiner. Studies have been prepared which show that the process is feasible for the refiner processing 3000 or more brl/day of crude oil ; (2) the competitive market for motor fuel points towards higher gasoline octane numbers in the future. Catalytic cracking will, in many cases, be the only means of economically reaching those competitive levels ; (3) the earnings from catalytic cracking at a given octane level are, in nearly every case, sufficiently greater than for thermal cracking to justify its installation ; (4) reduction in yield of residual fuel makes for greater flexibility in meeting many local market conditions ; (5) substantial investment savings can be achieved in many cases by using existing thermal equipment.

A. H. N.

## Polymerization.

**146. Polymerization and Isomerization are Effective in Motor-Fuel Manufacture.** Part 3. A. L. Foster. *Oil Gas J.*, 29.11.45, **42** (21), 103.—An epitome is presented of the catalysts specified in patents, mainly U.S.A., recorded during 1942–44, of which 25 relate to polymerization and 56 are for promoting isomerization of hydrocarbons. For polymerization, the most effective catalyst is phosphoric acid, supported on magnesium sulphate, or other inert medium, for promoting polymerization of light olefinic hydrocarbons to liquids of high anti-knock qualities simultaneously with a reduction of the vapour pressure to desirable limits and giving high yields from the feed stock. Of the 25 patents mentioned, 10 relate to the use of supported phosphoric acid in some form—*e.g.*, with copper metal, Ca and Cu phosphates, or with HCl as promoter ; pyro-phosphates of many metals with and without a promoter. Other catalysts noted include : aluminium chloride and a metal, or with a metal chloride. An interesting application is the use of spent $AlCl_3$ catalyst to reduce catalyst poison in the feed-stock before contacting with the $AlCl_3$ in the reactor. Another favours the use of supported $H_3PO_4$ and the addition of water at three points in reactor, to a total of 3% $H_2O$ at exit. One patent specifies the use of a solution of 67% $H_2SO_4$ and 2% $AgSO_4$ supported on a porous plate through which olefins enter and are emulsified and catalysed.

Isomerization can be accomplished on paraffins, olefins, *cyclo-* and aromatic hydrocarbons in two ways : (1) conversion of normal paraffins—*e.g.*, low-octane naphthas—to more branched-chain structures of improved octane ratings and high volatility ; (2) treatment of intermediate or raw stocks to prepare feed stocks for other operations such as alkylation—*e.g.*, treating butanes or pentanes, or combinations to form *iso*-paraffins containing tertiary carbon atoms for use as one of the intermediates in alkylation to produce high quality aviation components. That Friedel–Craft type catalysts are pre-eminently satisfactory in promoting the necessary rearrangement of the structure of hydrocarbons, is shown by the fact that 70% of the catalysts patented relate to an aluminium halide, mainly the anhydrous chloride. Many varieties of support are used. HCl is a favourite promoter. In three specifications, water is introduced in small quantities—1–1·5 times the weight of hydrocarbon reacted. Some interesting patents are : liquid-phase isomerization of low-octane naphthas by an $AlCl_3$-hydrocarbon complex ; $Al_2O_3$ plus $AlCl_3$ vapour, with periodic removal of a part of the catalyst bed for resaturation by $AlCl_3$ vapour and return to the reactor ; one patent relates to a method for the recovery of the aluminium halide from the isomerization sludge. Another condenses $AlCl_3$ vapour with the feed vapours and adds olefins to the condensate as a second part of the process to obtain an alkylation reaction. One patentee proposes the use of molecular hydrogen and anhydrous HCl heated to a temperature above the cracking reaction, and introduced to the reactor operating at 700° F. on $AlCl_3$ and feed. Other catalysts employed for olefin isomerization are :

bauxite and $H_2SO_4$ or $H_3PO_4$; brucite activated by $SO_3$ and HF or $BF_3$, with or without HF in molal excess of the $SO_3$. W. H. C.

## Chemical and Physical Refining.

**147. Unisol Process Improves Octane Number and T.E.L. Susceptibility.** C. D. Lowry and F. C. Moriarty. *Oil and Gas J.*, 3.11.45, **44** (26), 105.—The Unisol process of the Atlantic Refining Co. extracts mercaptans from gasoline by contact with caustic soda containing methanol. Operating costs approximate to 1–1½ cents/brl for chemicals and utilities. Advantages of the process include practically complete removal of all mercaptans from any gasoline; the octane number is not lowered nor inhibitor susceptibility adversely affected, and the methanol is separated from the caustic during each regeneration, thus the latter can be readily replaced. The process consists essentially of five steps, the first being the preliminary caustic washing to remove hydrogen sulphide, aliphatic acids, and phenols, followed by extraction of mercaptans and removal of methanol from the gasoline. The caustic methanol solution containing mercaptans is then regenerated by steam stripping, the methanol mercaptan and water vapours from the regeneration column are condensed to produce a two-phase system, from which the upper mercaptan phase is removed by skimming. The lower aqueous methanol phase is fractionated to recover the methanol. A table shows commercial results obtained from a wide variety of gasolines. G. A. C.

**148. Poisoning of Nickel Hydrogenation Catalysts by Water Vapour.** W. B. Burford, III, and J. C. W. Frazer. *J. Amer. chem. Soc.*, 1945, **67**, 331–332.—Water vapour is shown to be a poison for nickel hydrogenation catalysts, the effect being noticeable even with $3 \times 10^{-4}$ mm pressure of water vapour. The poisoning is reversible, the catalyst being reactivated by heating in hydrogen. E. H. W.

## Metering and Control.

**149. Chart Reading by the Integrator Method.** W. J. Kennedy. *Refiner*, Oct. 1945, **24** (10), 420–422.—The use of integrating methods for calculating flow rates by orifices is illustrated by examples. A. H. N.

**150. Calculations of Orifice Meter Charts by the Square-Root Planimeter Method.** J. T. Cortelyou. *Refiner*, Oct. 1945, **24** (10), 418–420.—The paper forms a part of the Southern California Meter Association Meter Course. A. H. N.

**151. Sight Reading of Orifice Meter Charts.** H. A. Faull. *Refiner*, Oct. 1945, **24** (10), 415–417.—The paper forms a part of the Southern California Meter Association Meter Course. The quantitative evaluation of the orifice formula by means of charts is presented. A. H. N.

# PRODUCTS.

## Chemistry and Physics.

**152. Ethylation of Benzene. Course of the Reaction.** E. M. Marks, J. M. Almand, and E. E. Reid. *J. org. Chem.*, 1944, **9**, 13–20.—Ethylated benzenes are obtained by reacting ethylene, or, less economically, ethyl chloride with benzene in the presence of aluminium chloride. The proportions of the products do not, as commonly supposed, depend only on the amounts of reactants. An attempt was made to study the reaction mechanism by using varying conditions, the products being separated by fractionation.

The amounts of the various homologues correspond roughly to the number of moles of ethylene used. A remarkable feature is that a large amount of hexa-ethylbenzene is formed in the early stages of the reaction, for of the first mole of ethylene used, 18% forms hexa-, and only 27% forms mono-ethylbenzene; for the second and third moles of ethylene introduced there is a slight decrease in hexa-ethylbenzene concentration, which afterwards rises to a maximum at about 6 moles of ethylene.

Variations in the ratio $C_6H_6/AlCl_3$ cause some change in the proportions of the

homologues produced, a small ratio resulting in a high percentage of 1 : 3 : 5-isomer, and less di- and penta-ethylbenzenes; the percentage of triethylbenzene is uniformly high.

Temperature variations cause marked changes in the proportions of the products, and small amounts of water have an accelerating effect on ethylene absorption in the early stages of the reaction. The rate of introduction and speed of stirring are also factors influencing the proportions of the products.

The results support the view that after complete alkylation of part of the benzene, a disproportionation occurs, producing largely 1 : 3 : 5-triethylbenzene, such redistribution being greatly affected by reaction conditions. C. N. T.

**153. Catalytic Hydrogenation of the Benzene Nucleus. I. The Hydrogenation of Phenyl-Substituted Aliphatic Acids.** H. A. Smith, D. M. Alderman, and F. W. Nadig. *J. Amer. chem. Soc.*, 1945, **67**, 272–276.—This work represents an attempt to determine the effect of structure on the rate of hydrogenation of the benzene nucleus.

The kinetics of the catalytic hydrogenation of phenyl-substituted aliphatic acids have been studied. The factors affecting the relative rates of catalytic hydrogenation are discussed. E. H. W.

**154. Catalytic Hydrogenation of the Benzene Nucleus. II. Hydrogenation of Benzene and Mono-alkylbenzenes.** H. A. Smith and E. F. H. Pennekamp. *J. Amer. chem. Soc.*, 1945, **67**, 276–278.—Continuing the work reported in the previous abstract, the kinetics of the catalytic hydrogenation of a series of mono-alkylbenzenes were studied. Factors affecting the relative rates of catalytic hydrogenation are discussed and the results of the present work are compared with previous publications. E. H. W.

**155. Catalytic Hydrogenation of the Benzene Nucleus. III. Hydrogenation of Poly-methylbenzenes.** H. A. Smith and E. F. H. Pennekamp. *J. Amer. chem. Soc.*, 1945, **67**, 279–281.—Studies of the kinetics of the catalytic hydrogenation of the poly-methylbenzenes and *p*-cymene are reported.

It is shown that increased methyl substitution generally decreases the rate of hydrogenation of the benzene nucleus, but the position of substitution is also important. The results are compared with those of other workers. Factors influencing the relative rates of catalytic hydrogenation are discussed. E. H. W.

**156. Foam Drainage.** G. D. Miles, L. Shedlovsky, and J. Ross. *J. Phys. Chem.*, 1945, **49**, 93–107.—The rate of flow of liquid through aqueous foams of uniform liquid concentration is studied under varying conditions. The foam is produced by blowing air through the solution and the liquid introduced at the top and collected at the bottom by a syphon. Solutions used include those of sodium lauryl sulphate, sodium lauryl sulphate + lauryl alcohol and two commercial preparations of sodium salts of sulphated glycerides.

Results are: (1) Establishment of a linear relation between the amount of liquid held by the foam and electrical conductivity. The latter is used as a measure of the equilibrium state of the foam; (2) If $y$ = rate of flow of liquid through the foam in cc/min, and $x$ = cc of liquid in the foam, then $y = ax^n$, where $a$ and $n$ are constants; (3) if $V$ = cc of liquid drained from the foam in $t$ seconds, $kt = V + a \log V + b$, where $k$, $a$, and $b$ are constants; (4) the rate of flow of 0·1% sodium lauryl sulphate containing 1% sodium sulphate shows a cumulative decrease as temperature is lowered, due to increased viscosity of the solution. A corresponding decrease is obtained when glycerol is added. The addition of lauryl alcohol shows an anomaly which is attributed to increased surface viscosity at the interface; (5) decrease in bubble size decreases rate of flow of liquid through the foam.

It is concluded that the relative drainage of liquid from foams cannot be regarded as a reliable measure of foam stability, owing to the many factors involved.

H. C. E.

**157. Relationships Between Velocity of Sound and Other Physical Properties of Liquids.** R. T. Lagemann and W. S. Dunbar. *J. Phys. Chem.*, Sept. 1945, **49** (5), 428–436.—

If $v$ = velocity of sound, $d$ = density of liquid, $M$ = molecular weight, and $v$ is a constant independent of temperature, then the new physical constant

$$v = \frac{M}{d} v^{1/3}$$

involving the velocity of sound in liquids, is found to be a linear function of the parachor, mole refraction, Souders' viscosity constant, molecular magnetic rotation, critical volume, and van der Waals' $b$ for members of four homologous series. The constants of the equations are evaluated. This implies that all the afore-mentioned properties are linear among themselves for homologous series. To a good approximation the linearity may be applied to all compounds. The critical temperatures and boiling points of homologous series of unassociated compounds are linear with the log of $v$. Lists of atomic increments and the accompanying constitutive values are compiled for several of the properties, including molecular sound velocity. Lists of bond increments are reported and their relationships noted. A. H. N.

**158. Flow Orientation in Isotropic Fluids.** A. Bondi. *J. Appl. Phys.*, Sept. 1945, **16** (9), 539–544.—A theory of flow orientation was developed which is based on a relation giving the change in entropy accompanying molecular orientation under the influence of a stress field, and on the applicability of the Eyring theory of viscous flow. The proposed theory predicts the ratio of the viscosity at attainment of complete orientation to the viscosity of "normal"—*i.e.*, random flow to be equal to the ratio of the average length $v^{\frac{1}{3}}$ to the actual length of the (fully stretched) molecule. The thermodynamics of a flow-oriented system are outlined, predicting the temperature changes, accompanying adiabatic orientation and disorientation. It is also suggested that the relaxation times in viscous media are large enough to prevent observation of flow orientation in capillary viscosimeters in many cases. A. H. N.

**159. Effect of Surface-Active Agents Upon Dispersions of Silica in Xylene.** V. R. Damerell, K. Gayer, and H. Laudenslager. *J. Phys. Chem.*, Sept. 1945, **49** (5), 436–442.—Dispersions of silica in xylene have been made in the presence of a number of surface-active materials. The particle-size distributions of these dispersions have been determined by sedimentation analysis. The most successful surface-active agents were found to be the various metal sulphosuccinates, metal naphthenates, and lecithin. These agents are thought to aid dispersion by forcing aggregates apart in the process of adsorption, since in all cases where adsorption was determined the successful surface-active agents were found to be strongly adsorbed on the silica. The silica had a surface of 118 sq m/g. It was positively charged in the xylene suspension, and was coagulated by the addition of water, alcohol, acetone, and ether. Heating also produced coagulation. A. H. N.

**160. Significance of Contact Angle in Relation to the Solid Surface.** D. C. Pease. *J. Phys. Chem.*, 1945, **49**, 107–110.—The significance of advancing, receding, and equilibrium contact angles ($\theta_a$, $\theta_r$, and $\theta_e$ respectively) are discussed in relation to work of adhesion to the solid surface. $\theta_a$ and $\theta_r$ occur when the surface is carefully dipped into or removed from the liquid. Assuming the system to be unidimensional, hydrophobic groups on the solid surface are responsible for $\theta_a$ and $\theta_e$; and hydrophilic groups for $\theta_r$. $\theta_a$ is dependent on the least possible amount of work required to wet the surface, or, inversely, to the least possible mean work of adhesion; and $\theta_r$ to the line of greatest possible mean work of adhesion. $\theta_e$ is a function of the line of the least possible work of adhesion that the three-phase junction can take up. H. C. E.

**161. Minima in Surface-Tension and Interfacial-Tension Curves.** G. D. Miles. *J. Phys. Chem.*, 1945, **49**, 71–76.—Following the results previously described (*J. Phys. Chem.*, 1944, **48**, 57), information on the relative surface concentrations of two-component mixtures of surface-active materials as a function of bulk concentration is presented.

Surface- and interfacial tensions are measured by a du Noüy Tensimeter, and selective adsorption of the surface-active material is obtained by bubbling air through the solutions to produce a large volume of foam. Curves of interfacial tension against concentration of sodium lauryl (dodecyl) sulphate against benzene shows no minimum; with sodium heptadecane sulphate as impurity a minimum is obtained. It is shown

that the minima of these and similar curves occur when the relative surface concentration of one of the components is a maximum. In opposition to the viewpoint that such minima can be explained as a critical concentration for micelle formation, a plot of specific (electrical) conductance and concentration for pure sodium lauryl sulphate (no minimum in interfacial tension) and for sodium lauryl sulphate with lauryl alcohol (minimum in interfacial tension) both showed discontinuities at the same point.

H. C. E.

**162. Minima in Surface Tension/Concentration Curves of Solutions of Sodium Alcohol Sulphates.** G. D. Miles and L. Shedlovsky. *J. Phys. Chem.*, 1944, **48**, 57–62.—The surface tensions of aqueous solutions of sodium dodecyl sulphate and sodium tridecane-2-sulphate are measured at concentrations up to 1/100 molar, using a du Noüy Tensimeter. Curves are presented showing the effect of: (1) dodecanol on the surface tension of sodium dodecyl sulphate solutions; (2) sodium pentadecane-2-sulphate and sodium heptadecane-2-sulphate on the surface tension of sodium tridecane-2-sulphate solutions; (3) sodium hexadecyl 2-sulphate on the surface tension of sodium dodecyl sulphate solutions.

The effect of impurity is always to introduce a minimum into the curves at about 5–6 M/1000 concentration. Case 1 is produced by two surface-active materials, of which one is only slightly soluble in water, and cases 2 and 3 occur with two anionic surface-active electrolytes. The latter effect is greatest when the impurity is either a homologue of higher molecular weight or another more surface-active analogue of the principal substance. Discussion centres around selective adsorption on the surfaces, and attention is directed to the possibility of the Gibbs adsorption theorem giving "anomalous" results when the materials are not carefully purified. H. C. E.

**163. Molecular Condition of Phenols in Benzene Solution.** J. A. Davison. *J. Amer. chem. Soc.*, 1945, **67**, 228–233.—A description is given of an apparatus for measuring the freezing points of dilute solutions (0·002–0·1 molal).

The cryoscopic constant of benzene was calculated from the freezing points of solutions of triphenylmethane in benzene.

Freezing points of solutions of phenol in benzene are given, and the results are interpreted as due to the formation of solid solutions of phenol in benzene.

Cyroscopic data are also presented for solutions of nitrobenzene in benzene. Freezing points of solutions of *o*-cresol, *p*-cresol, *m*-nitrophenol, *p*-nitrophenol, and 2 : 4-dinitrophenol in benzene are given. The equilibrium constants for the formation of dimers were calculated. E. H. W.

**164. Hindered Phenols.** G. H. Stillson, P. W. Sawyer, and C. K. Hunt. *J. Amer. chem. Soc.*, 1945, **67**, 303–307.—A series of 2 : 4 : 6-trisubstituted phenols, with *t*-butyl or other large hydrocarbon groups in the two positions ortho to the hydroxyl group, have been synthesized. These compounds have been characterized as the hindered phenols. They are insoluble in aqueous or alcoholic alkali and do not respond to any of the conventional tests and reactions of phenols. Evidence is given to support the structures assigned to them, and methods for the synthesis of these compounds and their derivatives are described. E. H. W.

**165. Reduction of Multiple Carbon Bonds. V. Reduction of Aromatic Hydrocarbons and Dialkylacetylenes by Calcium Ammonia.** K. N. Campbell and J. P. McDermott. *J. Amer. chem. Soc.*, 1945, **67**, 282–283.—The reduction by calcium ammonia of benzene, toluene, and three dialkylacetylenes is reported. Benzene gave *cyclo*hexene, toluene gave a mixture of two mono-olefins, and the dialkyl acetylenes were reduced to the corresponding *trans* olefins. E. H. W.

**166. Mechanism of Vinyl Polymerization. I. Rôle of Oxygen.** C. E. Barnes. *J. Amer. chem. Soc.*, 1945, **67**, 217–220.—An explanation is given for the inhibiting action of oxygen on the photopolymerization of vinyl compounds and some additional data are given. Oxygen is shown to exert a similar inhibiting action on thermal polymerization as well, and both these processes are shown to involve peroxide formation in preference to polymerization. E. H. W.

**167. Spectroscopic Analysis. Application of the Ultra-Violet Absorption Method to the Analysis of Mixtures Containing Aromatic Hydrocarbons.** R. R. Gordon and H. Powell. *J. Inst. Petrol.*, Nov. 1945, **31** (263), 428–449.—The principles, apparatus, and technique involved in the quantitative analysis of 2-, 3-, and 4-component mixtures of aromatic hydrocarbons by the ultra-violet absorption method are discussed in detail. A method has been evolved which is not dependent on comparison between the unknown mixture and synthetic blends. The mixtures dealt with are: (*a*) benzene–toluene; (*b*) the $C_8$ aromatics ethylbenzene, *ortho*-, *meta*-, and *para*-xylene; (*c*) *ortho*-xylene and *iso*propylbenzene. The accuracy attainable is calculated, and is illustrated by the analysis of a number of synthetic mixtures. The dependence of the error on the composition of the mixture is graphically illustrated, and the maximum possible error in this method of analysis is discussed. A. H. N.

**168. Isothermal and Adiabatic Compressibilities of Oil.** A. Cameron. *J. Inst. Petrol.*, Nov. 1945, **31** (263), 421–427, 494.—The work published on both the isothermal and adiabatic compressibilities of oils is considered, and average curves are given for both compressibilities over a range of temperatures. The ratio of isothermal to adiabatic compressibility equals gamma the ratio of the specific heats, which is shown to be 1·135 for mineral oils. A. H. N.

**169. Alkylation of *iso*Paraffins by Olefines in Presence of Hydrogen Fluoride.** C. B. Linn and A. V. Grosse. *Ind. Eng. Chem.*, Oct. 1945, **37** (10), 924–929.—The advantages of hydrogen fluoride as a catalyst for alkylation are discussed. Alkylation reactions with *iso*paraffins and olefines have been carried out in the laboratory using apparatus of simple design, by both batch and continuous processes. The experiments involved the paraffins, *iso*butane, and *iso*pentane, and the olefines propene, *iso*butene, 1-butene, and 2-butene, as well as the production of an alkylate from a butane–butene mixture. The effects of temperature, contact time, ratio of *iso*paraffin to olefin, and catalyst concentration in water are described. Normally the fluorine content of the alkylate is low, but can be reduced by certain materials such as calcium fluoride and aluminium fluorides at elevated temperature. The effect on octane number of small concentrations of fluorine (present as tertiary butyl fluoride) on a leaded and unleaded blend of 50% *iso*-octane and 50% straight-run gasoline is given. The major effect occurs for the leaded fuel, up to about 0·1% fluorine there being a loss of 1 octane number per 0·05% fluorine added. A. W.

**170.* On the Problem of Flameless Combustion.** G. N. Khudyakov and V. S. Pushkin. *Bull. Acad. Sci. U.R.S.S., Cl. Sci. Tech.*, 1945, 545–553.—A study is made of the flameless combustion of natural gas (methane 50%, hydrogen 15%, other hydrocarbons 25%) on the surface of particles of refractory material (chamotte and corundum). A slight excess (1–2%) of air was used. Curves are given relating the thermal potential to the particle size and particle area. Combustion was carried out in water-cooled iron tubes of varying diameter, a minimum value of the latter of 32 mm. was required in order to maintain the process. Examination of the temperature in various zones of the packed tube shows that the maximum temperature is rapidly attained close to the inlet point of the gas mixture; this combustion zone is situated at a height of 45–50 mm from the bottom of the tube. At a height of 70 mm combustion is complete. V. B.

**171. Vapour–Liquid Equilibria for Natural Gas–Crude Oil Mixtures.** C. H. Roland. *Ind. Eng. Chem.*, Oct. 1945, **37** (10), 930–936.—A consistent set of equilibrium constants and related phase data are presented for a mixture of natural gas and a crude oil for pressures from 1000 to 10,000 psi and at temperatures of 120–200° F. Data were also obtained for several oil and gas mixtures, and are compared to the data for the fixed-composition mixture. The effect of composition upon the equilibria is noted, and through two experiments in which the composition was varied by removal from the system of a liquid phase at a higher pressure, the effect of a particular composition change is determined. The composition change appears to affect the component characteristic of the heptanes and heavier component, but not the equilibrium constants. Coloured hydrocarbon fractions were observed in the vapour phase at high pressures. A. W.

**172. Redwood Products as Inhibitors of Oxidation in Petroleum Hydrocarbons.** H. F. Lewis, M. A. Buchanan, D. Fronmuller, and E. F. Kurth. *End. Eng. Chem.*, Oct. 1945, **37** (10), 988–990.—Redwood tannin preparations are shown to be effective inhibitors of the oxidation of mineral oil—for instance, 0·001% of a purified tannin shows an induction period of 11 hr as compared with 7 hr for the same amount of benzyl-*p*-aminophenol. The active inhibiting principles are present in the ethyl acetate-soluble part of the tannin fraction, and appear to be absent in the ethyl acetate-insoluble part. The ether-soluble tar and the phenol fraction obtained by a vacuum destructive distillation of redwood phlobaphene are both effective inhibitors for mineral oil. Redwoods, on destructive distillation, yield tars differing in composition from the hardwood tars; they are effective inhibitors and there appears to be no advantage in separating the phenolic fractions from them. A. W.

**173. Catalytic Cracking of Pure Olefinic Hydrocarbons.** B. S. Greensfelder and H. H. Voge. *Ind. Eng. Chem.*, Oct. 1945, **37** (10), 983—988.—Cracking over a silica–zirconia–alumina catalyst at 350–500° C of seven aliphatic olefines, two diolefines, two cyclic olefines, and two aromatic olefines was studied. The principal conversions of aliphatic mono-olefines were isomerization, cracking, saturation, and formation of higher-boiling materials and coke. Diolefines and aromatic olefines were extensively saturated and transformed to higher-boiling materials and coke. Catalytic and thermal cracking of olefines at 400–500° C are compared. The catalysed reactions, which are of the order of 1000–10,000 times as fast, yield larger fragments, involve much more isomerization, and lead to greater saturation of the products. A. W.

**174. Solubilities of Some Normal Saturated Aliphatic Hydrocarbons.** A. W. Ralston, C. W. Hoerr, and L. T. Crews. *J. org. Chem.*, 1944, **9**, 319–328.—The solubilities of octane, dodecane, hexadecane, heptadecane, and dotriacontane have been determined in benzene, *cyclo*hexane, tetrachloromethane, trichloromethane, ethyl ether, ethyl acetate, butyl acetate, acetone, 2-butanone, *iso*propanol, and *n*-butanol, eutectics being formed with the first four of these.

In less polar solvents the solubility curves are qualitatively similar to those of polar aliphatic compounds of similar chain-lengths; with solvents more polar than acetone, the solubilities decrease abruptly, the hydrocarbons being practically immiscible with strongly polar solvents such as methanol, ethanol, nitroethane, and acetonitrile. Polar aliphatic compounds are, however, generally miscible with these.

There is a pronounced correlation between hydrocarbon solubility and solvent polarity, and the possibility of molecular association is reviewed. Any deviations from a linear solubility/temperature relationship appear to be due entirely to intermolecular forces between paraffin chains, and to disparity between the polarities of solvents and hydrocarbons. The limited solubilities of the higher aliphatic compounds in highly polar solvents may be due to the difficulty such solvents have in overcoming the mutual attraction of the alkyl chains. C. N. T.

**175. Nomographs for Enthalpies of Pure Hydrocarbons and Their Mixtures.** E. G. Scheibel and F. J. Jenny. *Ind. Eng. Chem.*, Oct. 1945, **37** (10), 990–995.—Three nomographs present the vapour and liquid enthalpies of individual hydrocarbons and hydrocarbon mixtures. The first gives the enthalpies of normal paraffins from $C_1$ to $C_8$, and from a single setting on the nomograph, the enthalpy can be found for all the liquid components at a given temperature, and for all the components in the vapour at a given temperature and pressure. The second nomograph shows the liquid and vapour enthalpies of light hydrocarbon mixtures based on the average molecular weight of the mixture. The third nomograph gives the liquid and vapour enthalpies of the heavier petroleum fractions, and is based on a correlation of the properties of the various fractions of an oil with a characterization factor of 11·8. The last two nomographs are sufficiently accurate for general process calculations. A. W.

**176. Thermal Expansion and Second-Order Transition Effects in High Polymers. Part II. Theory.** R. F. Beyer and R. S. Spencer. *J. Appl. Phys.*, Oct. 1945, **16** (10), 594–607.—The nature of the thermal expansion anomaly in high polymers, known as the second-order transition, is examined in some detail. It is suggested

that below the transition temperature, *Tm*, polymer chains can expand sidewards but not parallel to their length. At *Tm* lengthwise expansion becomes prominent, thus accounting for the sudden increase in thermal expansion. Experimental results are presented showing the anisotropic expansion of oriented polymers below *Tm*. The transition effect is then treated as a problem in viscous flow, which gives rise to various semi-empirical plots connecting *Tm* with applied forces, plasticizer content, and time effects. The brittle point, $T_b$, involves highly elastic deformation, and is shown to be a fundamentally different test, although *Tm* and $T_b$ are sometimes numerically equal. Various factors influencing the brittle point are briefly reviewed. A. H. N.

**177. Molecular Weight Studies on High Polymers with the Electron Microscope.** R. F. Boyer and R. D. Heidenreich. *J. Appl. Phys.*, Oct. 1945, **16** (10), 621–639.—Some preliminary results are reported on measurements of molecular-weight distributions for polychlorostyrene. The following technique of isolating single polymer molecules is used: a precipitating agent, such as propanol, is added to a very dilute (1 ppm) solution of the polymer in benzene, presumably causing the molecules to coil up. Drops of this mixture are evaported on a silica screen and examined in the microscope. Circular particles ranging in diameter from 15A to 500A, and believed to represent single polymer molecules, have been obtained on various polymers. The relationship between measures particle diameter and molecular weight is reviewed in some detail. The data appear to favour the concept of a random coil to the extent that particle diameter varies as the square root of the molecular weight. The molecular-weight distribution curves obtained are of the expected shape and extent, although the average molecular weights computed from the distribution curves are 4–5 times greater than values measured by an independent method. Finally, the rôle of electrical charges in stabilizing isolated polymer molecules is discussed. A. H. N.

**178. Diethylstilbestrol and Related Compounds.** M. Rubin, A. Kozlowski, and M. R. Salmon. *J. Amer. chem. Soc.*, 1945, **67**, 192–193.—The synthesis is described of diethylstilbestrol and diethylstilbestrol monoethylether. E. H. W.

**179. Trans-2-Butene. The Heat Capacity, Heats of Fusion and Vapourization and Vapour Pressure. The Entropy and Barrier to Internal Rotation.** L. Guttman and K. S. Pitzer. *J. Amer. chem. Soc.*, 1945, **67**, 324–327.—It is shown that the potential barrier to methyl group rotation is around 2000 cal. per mole for both *trans*-2-butene and propylene. Heat capacities for solid and liquid *trans*-2-butene are reported from 15° to 270° K. and vapour pressures from 200° to 274° K. The melting point, heat of fusion, heat of vapourization, and the entropy of ideal gas at the boiling point are also reported. E. H. W.

**180. Structure of Spiropentane.** J. Donohue, G. L. Humphrey, and Y. Schomaker. *J. Amer. chem. Soc.*, 1945, **67**, 332–335.—From the results of an electron diffraction investigation, the $C_5H_8$ hydrocarbon prepared by Murray and Stevenson is confirmed to have the spiropentane structure assigned to it by these workers on the basis of the Raman spectrum. The dimensions for the molecule are given. E. H. W.

**181. Racemization, Alkylsulphuric Acid Formation, and Exchange in the Reaction between Acid-$d_2$ and Optically Active 2-Butanol.** R. L. Burwell, Jr. *J. Amer. chem. Soc.*, 1945, **67**, 220–223.—Following previous work on the racemization of *s*-butyl alcohol by sulphuric acid, evidence is now presented showing that a hydrogen exchange reaction accompanies the racemization when sulphuric acid-$d_2$ is used. The interrelations of these and other reactions taking place at the same time are considered. E. H. W.

**182. Vapour Pressures of *cis*- and *trans*-Decahydronaphthalene.** W. F. Seyer and C. W. Mann. *J. Amer. chem. Soc.*, 1945, **67**, 328–329.—The vapour pressures of *cis*- and *trans*-decahydronaphthalene are reported over a range of temperature of − 30° to 223° C. The critical temperatures, latent heats, and Trouton constant are calculated from the data. E. H. W.

**183. New Syntheses of Picene.** M. S. Newman. *J. org. Chem.*, 1944, **9**, 518–528.—Syntheses of picene, by two closely related methods, and also of 5-methylpicene, 13-methylpicene, and 13-picenol, together with the necessary intermediates, are described in detail.

Many earlier syntheses involved aluminium chloride catalysed intramolecular cyclizations, resulting in poor yields; in the case of methylated products also, the positions of these substituents were rather doubtful, owing to the known lability of alkyl groups in Friedel–Crafts condensations. Methods closely related to previously developed chrysene syntheses (M. S. Newman, *J. Amer. Chem. Soc.*, 1938, **60**, 2947–51; 1940, **62**, 870–4, 2295–300) are used, and are generally applicable for mono- or poly-substituted picenes, and lead undeniably to the expected products. C. N. T.

**184. Dichlorodiphenyltrichloroethane. I. Solubility in Various Solvents.** F. A. Gunther, *J. Amer. chem. Soc.*, 1945, **67**, 189–190.—The weight per cent solubility of dichlorodiphenyltrichloroethane (D.D.T.) has been determined for the following purified solvents: acetone, benzene, carbon tetrachloride, chloroform, ether, 95% ethanol and petroleum ether (30–60°), for the temperature range 0–48° C. Approximate data was also obtained for the solubility of D.D.T. in dioxane and pyridine. It is concluded that from the solvents examined benzene is the most efficient for the removal or " stripping " of D.D.T. at room temperature. E. H. W.

**185. Corrosion of Lead by Oxidising Agents and Lauric Acid in Hydrocarbon Solvents.** C. F. Prutton, D. Turnbull, and D. R. Frey. *Ind. Eng. Chem.*, Oct. 1945, **37** (10), 917–924.—Rates of corrosion of pure lead by representative organic peroxides in hydrocarbon media containing organic acids are compared. Organic oxidizing agents other than peroxides or oxygen may be effective in causing corrosion of lead in these media; oxy-nitrogen compounds, quinones, and diacetyl are agents of this type. For hydroperoxides and oxygen it is likely that lead hydroxide or lead oxide is intermediate in the corrosion process. For other types of peroxides and non-peroxidic oxidizing agents the evidence indicates that there is no metal oxide or hydroxide intermediate in the process. Reactivity of oxidizing agents towards lead are compared at a constant acid concentration. To evaluate the effective corrosivity of an oil, it is necessary to consider the thermal stability of the oxidizing agent as well as its chemical reactivity. Evidence is cited to show that oxy-nitrogen compounds, as well as peroxides and oxygen, may be among the oxidizing agents present in oils.
A. W.

**186. Preparation of Alkyl-lead Salts.** G. Calingaert, F. J. Dykstra, and H. Shapiro. *J. Amer. chem. Soc.*, 1945, **67**, 190–192.—Improved methods for the preparation of some alkyl-lead salts have been developed, and the following new salts were prepared: diethyl-lead dihydroxide, diethyl-lead carbonate, triethyl-lead bicarbonate, and trimethyl-lead acetate. E. H. W.

## Analysis and Testing.

**187. Determination of Metals in Lubricating Oils.** L. Lykken, K. R. Fitzsimmons, S. A. Tibbetts, and G. Wyld. *Refiner*, Oct. 1945, **24** (10), 405—414.—*Paper Presented before the Petroleum Division of the American Chemical Society.* Detailed procedures are given for the determination of lead, copper, cadmium, barium, tin, silica, zinc, iron, aluminium, calcium, magnesium, and alkali metals in new or used lubricating oils without interference from other elements, such as sulphur, phosphorus, and chlorine. In the general procedure for all elements except lead the oil is ashed by ignition in air; the ash is treated with acid and copper. Cadmium, tin, silica, and barium are obtained in the residue after adding hydrogen sulphide and sulphate ion. Iron, aluminium, and zinc are separated from the remaining ions as hydroxyquinolates. For the principal metals the general method is accurate to $\pm$ 5% of the amount present. In the simplified, direct method the oil is oxidized with nitric and sulphuric acids, and the lead is determined as lead sulphate after removing interfering elements; iron and copper are determined colorimetrically either on the ash or on the residue obtained after oxidation with nitric and sulphuric acids. The direct method is

accurate to ± 0·01% lead and ± 0·001% iron and copper, regardless of the other elements present. Data are given on the application of the method to synthetic oil samples and inorganic solutions. A. H. N.

**188. Determination of Small Amounts of Sulphur in Naphthalene.** J. A. Hinckley, Jnr, M. C. Wilson, H. McKnight, and B. B. Corson. *Ind. Eng. Chem.* (*Anal.*), Oct. 1945, **17** (10), 642–646).—A method, described for the determination of sulphur in naphthalene, is applicable to the sulphur range of 0·002–2%. The method involves combustion in a current of purified air and the turbidimetric determination of sulphur as barium sulphate. It is applicable not only to naphthalene, but to other high-boiling organic materials. Figures are given for the absolute error which approaches 40% in the range 0·002% sulphur content. A. W.

**189. Low-Temperature Viscometer.** Y. A. Pinkevich. *Petroleum*, Nov. 1945, **8** (11), 214.—Based on the Ubbelohde–Holde method, an apparatus has been devised for the determination of viscosities of oils at temperatures down to − 50° C. The viscometer is of the U-tube pattern, the oil under test being filled into the apparatus to the appropriate marks, and then a determined amount of dyed alcohol poured on top of the oil. The apparatus is placed in a thermostat and connected to a source of pressure; the time of flow of the alcohol into a bulb and out again on release of the pressure is noted.

The absolute viscosity $\eta$ is calculated from the usual expression $\eta = cPt$, where $P$ is the pressure in mm of mercury, $t$ is the mean time of flow in seconds, and $c$ is the constant for the viscometer. Experimented work has shown that neither alcohol nor gasoline mix with the oil under the test conditions. It is claimed that the accuracy of the method attains 0·5%. The method may also be applied to the determination of the absolute viscosity of opaque petroleum products at higher temperatures using a higher alcohol. G. A. C.

**190. Petroleum-Oil-Spray Deposits on Citrus Leaves.** J. B. Redd. *Ind. Eng. Chem.* (*Anal.*), Oct. 1945, **17**, (10), 621–623.—A method is presented for the determination of the amount of oil deposited by oil sprays on citrus leaves and the amount retained after a period of several weeks. Errors due to the extraction of variable amounts of plant waxes are largely overcome by sulphonation of the petroleum ether extract. The petroleum ether containing the unreacted oil is separated and this oil weighed after evaporating the ether. A. W.

## Engine Fuels.

**191. Determination of Cetane Value from Average Boiling Point and Specific Gravity.** G. Vorberg. *Refiner*, Oct. 1945, **24** (10), 394–396. (Translated by E. J. Barth from *Oel u. Kohle*, 1943, **39**, 847–850.)—A simplified procedure has been developed to determine cetane numbers of diesel fuel oils based on the simple procedure of determining the density and boiling point of the fuel, and by the use of tables which have been empirically developed from engine-test data. The fundamentals of the method were originally worked out by Heinze and Marder; this work led Marder to develop and devise the gravity method known by his name. The procedure outlined in this report will give the cetane number which is comparable to values obtained by the engine method. The specific-gravity method of Marder furnishes cetane numbers which were checked and based on the throttle method of engine-test procedure. The procedure is applicable to all sundry fuel oils of diverse origins except for those which contain antiknock additives; the latter type are not commonly found in the market today. The advantage of the procedure is its simplicity, its good agreement with the results of the motor-test method for determining cetane numbers by the ignition method. A. H. N.

**192. Slow-Motion Pictures Throw New Light on the Cause of Knock in Fuel Combustion Camera Developed by N.A.C.A. Engineer Photographs Burning of Fuel in Engine Cylinders at the Rate of 40,000 Frames a Second. Aids Knock Study.** Anon. *Nat. Petrol. News Tech. Sect.*, 3.10.45, **37** (40), R773.—An important contribution to the study of combustion in i.c. engines has been made, and was the subject of a

paper presented at the Cleveland S.A.E. by C. D. Miller on 17th May on "Slow Motion Study of Injection and Combustion in a Diesel Engine." Since 1936 he has developed a camera which will record 40,000 pictures per second, and which since 1938 has been used almost exclusively in the study of spark-ignition engine knock in the war-time projects of the National Advisory Committee for Aeronautics. The apparatus and procedure are briefly described. Normally cinematograph films are recorded and screened at the rate of 16–24 pictures per second; the high-speed recordings are projected at a rate 2500 times slower than the actual duration of the combustion reaction—*i.e.*, 16 pictures per second, which is 1 in per second as the apparent average speed of the spray tip scaled to the actual combustion-chamber dimensions, in comparison with the actual speed of the injection spray tip, found in some of the studies to be 210 ft/sec. Injection and combustion of fuel in a diesel engine are shown in a series of 198 photographs taken in 0·005 sec, which shows the beginning of injection in the second picture and the commencement of combustion in the 104th and the combustion peak at the 198th exposure. In the original negative the beginning of combustion is first apparent in the 99th picture. Still higher speed will be needed to complete the knowledge. The multiple and single orifice nozzles used are shown by dimensional diagrams. The author's summary is as follows :—

"The high-speed photographs demonstrate the better fuel distribution by the multiple-orifice nozzle as compared with the single-orifice nozzle on the basis of actual comparative combustion. They illustrate how diesel knock associated with short inflammation time develops with increasing injection advance angle. They show the increasing ignition lag and consequent increased vaporization with increasing injection-advance angle, and also the increased smoke formation with large injection-advance angles. The rare occurrence of a phenomenon probably identical with spark-ignition engine knock has been demonstrated in the diesel engine. Finally it has been demonstrated how mixtures too lean for combustion may be formed by early injection with very small fuel quantities, whereas the same mixtures will burn with later injection because of the concentration of the fuel in droplets."

W. H. C.

**193. Chemical Composition and Road Antiknock Performance of Postwar Motor Fuels.** Jane F. Jordan. *Nat. Petrol. News Tech. Sect.*, 3.10.45, **37** (40), R777.—The extensive advances in the production of gasoline blending components during the war has given refiners wide choice of materials for improving peace-time motor fuels. This paper reviews the opportunities for such, and also the C.F.R. research and A.S.T.M. motor methods, the latter being designed to correlate with the C.R.F. Uniontown road method. For blending motor fuels to fit engine requirements the Borderline antiknock test method is eminently suitable, as it indicates the actual road anti-knock performance of a gasoline by means of a curve which shows the ability of a fuel to tolerate spark advances throughout the entire engine-speed range. The borderline method, procedure, and the equipment necessary for a test car are briefly described, and anti-knock tests have been made on various saturated and unsaturated gasolines, without and with T.E.L. additions, and with various blending components, etc., without and with various additions of T.E.L. The results are shown on twelve charts, the borderline curves representing spark advance (vertical axis) and the "engine-die-out speed" (horizontal axis) with the distributor spark advance curve superimposed. The results of the tests are fully discussed in relation to fundamental variations in fuel types; sensitivity as a criterion of fuel quality; the effect of type of light blending components; effect of olefins in the higher boiling range. In general, improvements can be made in average fuels by altering their composition so that they approach the type of fuel whose borderline pattern parallels the distributor spark advance curve of the average motor engine: (1) by substituting a small amount of high-boiling paraffinic, naphthenic, or aromatic material for the high-boiling olefinic hydrocarbons normally contained in highly cracked fuel; (2) by adding light olefinic or aromatic material to a straight-run fuel; (3) by blending refinery stocks with due consideration to the effect of such blending on the road lead susceptibility of the fuel throughout the speed range, so that the maximum advantage is obtained from the lead additions; (4) by using light olefinic material rather than light paraffinic material to adjust volatility.

An attempt has been made to show the greater meaning of the actual road anti-

knock performance of motor fuels over their indicated laboratory values. Greater awareness of the implications of the newer refining methods for improving anti-knock characteristics will permit the selection of new equipment which will complement existing plant facilities. W. H. C.

## Lubricants.

**194. Sulphonic Derivatives as Lubricating Additives.** G. G. Pretzker. *Nat. Petrol. News Tech. Sect.*, 3.10.45, **37** (40), R.793.—One hundred U.S. patents from 1927 to 1943 are surveyed, including 16 for 1944 and 7 for the year 1945. Sulphonates from acid refining of petroleum distillates, obtained either from the treated oils or the acid sludge, are widely used as additives for lubricating oils. In this survey the dopes are divided into three groups: (1) as the sole additive; (2) in combination with other additives forming a reaction product or co-acting with other additives to produce a more potent oil additive; (3) acting in a subordinal manner to the chief additive as emulsifiers, non-jelling or detergent agents.

The survey outlines various patents giving the source and type of the dope, and, where specified, its manufacture and the formula of the doped lubricant.

Recent 1944–45 patents include: Group I. Waugh (U.S.P. 2,342,027) specifies salts of esters of sulphocarboxylic acids—*e.g.*, calcium salts of dioctyl esters of sulphosuccinic acid for corrosion inhibition. Highee (U.S.P. 2,361,476) describes the method of producing calcium sulphonates from petroleum sulphonic acids for use as engine dopes. Morgan (U.S.P. 2,355,994) obtained an improved oil emulsion additive by chlorinating Duvall crude oil with a catalyst containing an organic halide, and treating the intermediate product with chlorosulphonic acid and neutralizing with an alkali.

Group II. Reudrich (U.S.P. 2,367,435) found that marked improvement of sulphonates could be obtained by oxidizing the sulphonated product with $KMnO_4$, which removed corrosive materials. Mixon (U.S.P. 2,367,469) obtained dopes which prevented corrosion, ring-sticking, wear, sludge, and varnish in gasoline and diesel engines, by reacting polymers with chlorsulphonic-acid and neutralizing and reacting the product with sulphur and/or phosphorous-containing products such as $S_2Cl_2$, $SCl_2$, $P_2S_5$, $P_4S_7$, $PCl_3$, $PCl_5$, and $P_2O_5$.

Group III. Svenson (U.S.P. 2,349,058) found a complex soap of Pb and metal of the alkali and alkaline-earth group with a mahogany sulphonate or naphthanate of Na, K, Ba, Al, Fe, or Pb to solubilize the former, gave an improved E.P. additive; Van Ess (U.S.P. 2,352,669) states that thioallophanates and allophanates act as carbon softeners in lubricants susceptible to such formation, and salts of Mg, Ca, Sr, Ba, Zn, Cd, Al, Sn, Pb, Bi, Cr, Mn, Co, Ni, and organic amines of petroleum sulphonates, when added to the former, act as detergents; Lincoln (U.S.P. 2,353,170) shows that benzene and naphthalene sulphonic acids impart E.P. properties and reduce wear in lubricating oils; to solubilize E.P. agents of the dithiophosphate type—*e.g.*, barium dilauryl dithiophosphates in lubricating oils, Cook (U.S.P. 2,369,132) uses petroleum sulphonate dialkyl sulpho-succinate, di*iso*butyl naphthalene sulphonate, lauryl phenyl sulphonate, esters of sulphophthalic acid, lauryl sulpho-sulphbutyrate, esters of sulpho sebacic acid, capryl phenyl ester sulphonate, and sulphonated esters of talloel fatty acids; Van Ess (U.S.P. 2,372,411) discloses that petroleum sulphonates improve lubricants containing as the chief improving agent zinc di*iso*propyl salicylate.

W. H. C.

**195. Carbide's New Non-Petroleum Motor Oil on Sale in Two States Experimentally.** V. B. Guthrie. *Nat. Petrol. News*, **37** (42), 10.—Carbide and Carbon Chemicals Corpn have announced the commercial production of new type lubricating oils from non-petroleum sources, which are wax free and can be produced to any viscosity. Pour points range from − 70° F to − 80° F, and flash-points are above 300° F. They have a density about that of water, give carbon residue values of less than 0·01%, and have viscosity indices of 140–160. They are characterized by low changes of viscosity with temperature. The particular advantages claimed are practical elimination of sludge and varnish formation in the engine and ease of starting in cold weather. Wear is in line with that experienced with ordinary mineral oils. The products (now marketed as Prestone) have been extensively used for military purposes, and

have been exhaustively tested in internal-combustion engines. Details of the process by which the oil is made have not been disclosed, but the raw material is known to be natural or refinery gas. C. L. G.

**196. Oxalic Acid in Oils.** Anon. *Chem. Tr. J.*, 28.12.45, **117** (3058), 746.—An article by S. S. Bhatnagar and K. G. Krishnamurthi in the Oct. issue of the *Journal of Scientific and Industrial Research* of New Delhi describes recent research work on the incorporation of up to 0·05% of oxalic acid or ethyl oxalate in blends of mineral and vegetable oils used as lubricants (Ref. Indian Pat. 29,408 of 1943). It is pointed out that additives for restricting or inhibiting oxidation changes in vegetable oils consist of: (1) hydroxy compounds (phenolic derivatives, naphthols, etc.); (2) nitrogen compounds (naphthylamines and aniline derivatives); or (3) certain halogen, sulphur, and phosphorous compounds. Most of these have two effects on the lubricating oil, decreasing oxidation rate or lengthening the induction period and counteracting the effect of metals which serve as oxidation accelerators. Few, however, have any specific effect on the metal in inhibiting corrosion from free acids or oxidation products from the oil. It has now been found that dibasic dicarboxylic acids have this specific effect, possibly as a result of formation of a protective film of, *e.g.*, oxalate on the metal. In combination with effective anti-oxidants such as α naphthol corrosion of bearings and oxidation of the oil are minimized to a remarkable degree.

C. L. G.

**197. Lubricant Developed for Jet-Propulsion Engines.** Anon. *Oil Gas J.*, 18.8.45, **44** (15), 106.—Shell Oil Co's Wood River Laboratory have developed a lubricating system for jet-propulsion engines which employs a mist-like spray consisting of 95% chilled compressed air and 5% oil. This is directed on the ball bearings at either end of the engine on which the single longitudinal axle revolves. The air cools the metal, and the oil protects it from foreign matter and rust. The spray is finally exhausted into the jet.

The lubrication problems of jet-propulsion engines are compared with those of the conventional internal-combustion aircraft engine, and the properties of the ideal jet-engine lubricant are discussed. T. M. B. M.

**198. Identification of Type and Classification of Lubricating Greases By Visual and Photographic Means.** A. E. Hickel. *Refiner*, Oct. 1945, **24** (10), 397–399.—A new empirical test is described for identifying the type of soap in grease by means of the pattern the grease leaves on breaking between two discs. The pattern may be either visually examined or photographed. A. H. N.

## Asphalt, Bitumen and Tar.

**199. Flow Test for Asphaltic Bitumens.** Anon. *J. Inst. Petrol.*, Nov. 1945, **31** (263), 450–451.—The sample is put in a special hollow L-shaped mould, and the extent to which it flows under standard conditions is measured. A. H. N.

**200. Use of Mechanical Tests in the Design of Bituminous Road-Surfacing Mixtures. Part I. Dense Tar Surfacings.** A. R. Lee and P. J. Rigden. *J. Soc. chem. Ind.*, 1945, **64**, 153–161.—The term "dense tar surfacing" is used to denote a material containing stone, sand, filler, and a tar binder, the mixture having to be spread hot and consolidated with a roller. The paper describes how the results of investigations of mechanical properties of laboratory-made specimens of surfacing material may be used for deciding the proportions of the four constituents to give a satisfactory mixture for use on the road. Resistance to deformation is important and a simple tensile strength method of test has been standardized. It is shown that for given constituents, formulæ or a series of graphs may be used to determine the optimum mixture. Specifications of the materials are given and procedure for mixing and laying. The resistance to skidding of these surfacings is generally good.

F. J. W.

**201. Manufacture and Laying of Dense Tar Surfacings.** H. G. Barnes and G. H. Fuidge. *J. Soc. chem. Ind.*, 1945, **64**, 271–274.—This paper is complementary to the one above, and is a review of the practical results achieved with experimental dense tar surfacings having compositions decided largely by the method of Lee and Rigden. These were laid on Surrey roads carrying considerable Army transport and tanks, and although present experience is over a comparatively short period of time, the general conclusion is that dense tar surfacings can form a satisfactory road surface capable of carrying very heavy traffic. The surfacings designed by the theoretical method were found in practice to have maximum wearing qualities. F. J. W.

**202. Bitumen and the Bitumen Industry.** 5 (1) **Industrial Applications of Asphaltic Bitumen.** J. S. Jackson. *Petroleum*, Nov. 1945, **8** (11), 216.—A selective survey is given of the many industrial applications of bitumen as distinct from use in road construction. In the specialized process for the manufacture of roofing felt, bitumen is the impregnating and coating material. The dry felt is passed through soft molten bitumen, then through heated press rollers to remove excess bitumen, and after cooling a coating of a blown grade of bitumen is applied to both surfaces, and then dusted with a mineral powder to prevent sticking. After cooling the felt is reeled for storage. The properties of the coating material are important, climatic conditions in country of use influencing choice of impregnant, for example the saturating and coating media should be compatible to avoid separation.

Bitumen is also used in the manufacture of floorcloth, and in bitumenized paper products for the packing trade. Double kraft paper consists of two sheets of brown paper cemented together with a thin layer of suitable bitumen, and is water-proof and of considerable mechanical strength. Dispersions of bitumen in clay emulsion, as thixotropic pastes containing up to 60% bitumen are used for the manufacture of bituminous paper and boards.

As an impregnant for the jute or hessian wrappings of electric cables, and in joint box, trough and sealing compositions bitumen finds use. Blown grades are employed for manufacture of compositions for lining and coating steel pipes, the compositions being chosen as a result of laboratory flow and shatter tests. It has been shown that internal linings do not decrease the carrying capacity of the pipe.

G. A. C.

## Special Hydrocarbon Products.

**203. Solvents for D.D.T.** H. A. Jones, H. J. Fluno, and G. T. McCollough. *Soap*, Nov. 1945, **21** (11), 110.—The U.S. Bureau of Entomology and Plant Quarantine have determined the solubility of relatively pure D.D.T. at 27–30° C. in a wide range of organic solvents, aliphatic, and aromatic petroleum fractions, coal-tar fractions, pine distillation products, etc. Two methods were used for determing solubility: (1) adding increments of solvent to a given weight of D.D.T. at intervals of time with agitation until complete solution is obtained; and (2) plotting a curve of refractive index of solutions of known concentrations and extrapolating this to the refractive index of a saturated solution. Physical properties of some useful solvents for D.D.T. are tabulated, and advice given on the selection of the appropriate solvent for different purposes. C. L. G.

**204. Insecticide Toxicity Studies. Experimental Results on Comparative Toxicity of Benzene Hexachloride, D.D.T. and Pyrethrum.** W. A. Gersdorff and E. R. McGouran. *Soap*, Nov. 1945, **21** (11), 117.—Tests on the toxicity to houseflies of kerosine solutions of the gamma isomer of benzene hexachloride, the para para isomer of D.D.T. and pyrethrins, have been carried out using the turn-table method. A range of concentrations was tested and the concentrations giving 50% mortality (24 hr kill) were determined graphically. These concentrations were: Benzene hexachloride 0·0888 mg/ml, D.D.T. 0·788 mg/ml and pyrethrins 1·61 mg/ml. The ratios of toxicity of the two former products to pyrethrins at 50% mortality level were thus 18·1 and 2·04 respectively. At these concentrations the knockdown (25 min) given by benzene hexachloride and D.D.T. were very considerably smaller than those given by pyrethrins. C. L. G.

## Derived Chemical Products.

**205. Oxidation of Paraffins.** Part III. E. Stossel. *Oil Gas J.*, 1.9.45, **44** (17), 69.—Following two previous articles (see abs. Nos. 1387/8) on the preparation of fats and soaps in Germany by oxidation of Fischer–Tropsch slack wax, the industrial application and methods for purification of the crude oxidation products and separation of different classes of these from the mother mass are discussed.

The mass production of fatty acids for the soap industry placed large quantities of by-products on the market, as only the $C_{10}$–$C_{18}$ fatty acid fraction (60–70% of the total fatty acid yield even when oxidation is very carefully controlled) can be used for soap-making.

The acids below $C_7$ are used in the leather industry in crude form, or may be worked up by methylethyl ketone–benzene extraction, or by distillation to purer products. Acids in the range $C_7$–$C_9$ have proved to be important in the form of their esters as plasticizers for synthetic resins, and their amides find use in the paint industry. Their metallic soaps have found application in the paper industry (aluminium salts) and in grease-making. Not much is known about the utilization of the residue containing acids with more than 18 carbon atoms, except as a raw material for shellac substitutes and as rubber filler. It may be used also after saponification in the production of lubrication greases.

Only about 25–30% of the total crude reaction product consists of fatty acids, the unsaponifiable matter consisting of: (*a*) unattacked hydrocarbons; and (*b*) neutral oxidation products, *e.g.*, alcohols, aldehydes, and ketones of the same range as the fatty acids. Separation of (*b*) from (*a*) may be effected by selective solvent extraction, distillation, or esterification. Aldehydes can be separated from (*b*) by formation of their sodium bisulphite compound, and alcohols by esterification (*e.g.*, with phosphoric acid).

The yield of alcohols from the oxidation process can be greatly increased by carrying this out in presence of weak inorganic or organic acids of low molecular weight, such as boric or acetic acids. The resulting esters are separated from the crude reaction product by solvent treatment and purified from fatty acids by: (*a*) precipitation from the solvent with low boiling petroleum; or (*b*) saponification and extraction of the soap solution. The crude oxidation product containing the boric acid esters can be used for the preparation of creams, polishing waxes, and wax pencils. Oxidation can also be carried out in presence of boric acid using air laden with acetic acid vapour.

Alcohols and aldehydes were found of value in the perfume industry, as stabilizers, foam-preventing agents, wetting agent manufacture, detergents. The reaction products of alcohols with phosphorus oxychloride are used in the production of extreme-pressure lubricants. Higher fatty alcohols are in demand because of the detergent properties of their sulphonates and phosphates, and also for the synthesis of waxes.

In the author's opinion it is doubtful whether the Fischer–Tropsch process can compete under normal world market conditions with natural petroleum products, since slack wax became available in Germany only owing to the high production of synthetic gasoline and oils for war purposes. Many of the other available raw materials need refining or solvent treatment before they can be oxidized satisfactorily.

A list of references covering the three articles is included. T. M. B. M.

**206. Ethylene—A Raw Material for the Chemical Industry.** R. M. Bridgwater. *Petroleum*, Nov. 1945, **8** (11), 209.—Ethylene has a special place in syntheses owing to its simple structure and readiness to react. There are three potential sources, from ethyl alcohol, from coal by carbonization and from refinery gases. Fermentation of molasses provides industrial alcohol, 175,000 tons being produced in 1938, from which 106,000 tons of ethylene could be made. The two carbonization industries of Great Britain yield gas containing from 1 to 2% of ethylene, but the low concentration presents isolation difficulties.

Adsorption, solution, thermal diffusion, and liquefaction are possible methods of separation. Existing standard liquefaction processes are not designed for separation of ethylene, but the Linde–Brown method for the separation of hydrogen from coke-oven gas by liquefaction of all the other constituents yields a first fraction containing 30·6% of ethylene. The liquid mixture could be fractionated to obtain pure ethylene.

Refrigeration processes using a Claude-type expansion cylinder or a Kapitza expansion turbine require investigation.

World production of ethylene in 1942 was 2,000,000 tons from the cracking and reforming processes in the petroleum industry, the ethylene being separted from the refinery gases by fractionation under pressure. Other methods, such as direct hydration, or treatment with chlorine water, are being investigated, but fiscal arrangements largely influence the possibilities of producing ethylene from petroleum in this country. The main uses and products of ethylene are tabulated. G. A. C.

**207. New Synthesis of Acrylic Acid.** Anon. *Mod. Plastics*, Nov. 1945, **23** (3), 162.—A report was presented by Dr. Reppe of the I.G. Farbenind. A.G. at the Plastics Committee Meeting in Frankfurt-am-Main on Dec. 11, 1940, on a new synthesis of acrylic acid from acetylene, carbon monoxide, and water, using nickel carboxyl as the CO carrier. It is assumed that the first reaction is the formation of unstable *cyclo*propenone, which then combines with compounds containing labile hydrogenations, giving with water acrylic acid, and with alcohols acrylic esters. When nickel carbonyl is used as the CO carrier the presence of halogens or acids is necessary to bind the metal of the carboxyl as a salt. The reaction proceeds violently, but gives practically quantitative yields. The nickel carbonyl can be simply regenerated from the nickel salt by addition of ammonia and treatment of the resulting hexamine-nickel-2 chloride with carbon monoxide, yielding the carbonyl and an aqueous solution containing ammonium chloride and ammonium carbonate, the ammonia of which is regenerated with milk of lime.

The cost of production of acrylic acid and derivatives by this process is relatively low, and a semi-commercial plant at Ludwigshafen produced 30/50 t.p.m. of acrylic ester.

A similar reaction takes place with olefins, the unstable alkyl *cyclo*propanone splitting in either possible direction to give straight-chain and α-methyl-substituted carboxylic acids (with water) or esters (with alcohols). Yields here are also quantitative, and the possibilities of producing higher fatty acids and esters from olefins are being studied.

A further process—the so-called OXO synthesis of the Ruhrchemie—similarly depends on the splitting of the intermediate *cyclo*propane ring, thus producing from olefins, carbon monoxide, and hydrogen, straight-chain and α-methyl aldehydes, which can be converted into alcohols by hydrogenation.

The new carbonyl reaction is expected to play an important part in organic synthesis. Interesting possibilities are the production of hydrindone (containing 4 mols. of acetylene and one of carbon monoxide) and the reaction of aldehydes and ketones with acetylene in the presence of metallic carbonyls yielding acids. C. L. G.

**208. Hydrogenated Solvents.** A. E. Williams. *Paint Manufacture*. Nov. 1945, **15** (11), 325.—The value of *cyclo*hexanol and of tetrahydronaphthalene to the paint and varnish industry is discussed and small-scale units for their manufacture are described. Hexalin (*cyclo*hexanol) is of particular value as a solvent for synthetic resins, particularly as up to 5% of a diluent can be absorbed. In nitrocellulose lacquers it is used to reduce the viscosity and to prevent blushing, but it is not a direct solvent for the nitrocellulose. It is also a useful homogenizing agent in varnishes and lacquers. Tetralin is not a good solvent for phenol formaldehyde resins in the cold, but dissolves most other synthetic and natural resins, etc. Its high flash point (80° C.) reduces evaporation losses and increases safety, but leads to slow drying in varnishes, etc.

Typical plants are described for the production of hydrogen for the manufacture of these solvents, by the steam-iron and electrolytic methods, and typical batch or continuous hydrogenation units described, with brief indications of optimum processing conditions, precautions necessary, etc. C. L. G.

**209. Coal Chemicals in the North-East. Proposals of Northern Industrial Group.** Anon. *Chem. Tr. J.*, 14.12.45, **117**, 686.—The Coal Processing Industries Panel of the Northern Industrial Group have issued two reports proposing developments in the coal-products industry, which are now under the consideration of the Ministry of Fuel and Power. It is proposed to establish a chemical industry in the North

based on coal and coal-tar products normally exported from this area, with particular respect to the production of raw materials for the plastics industry by further refining of tar distillates. With assistance from the Government, an organization would be set up to develop the extraction of ethylene from coke-oven gas, and to develop the use of the Fischer–Tropsch process, if this is to be used for the production of oil from coal. It is proposed that a plant for phthalic anhydride should be set up in this area, and that the present multiplicity of small-scale tar distilleries should be replaced by large central plants. The chemical possibilities of anthracene and other high-boiling derivatives should be explored. Production by coal power of carbide for organic chemicals would require heavy subsidies. It is pointed out that 1000 million cu ft of coke-oven gas would yield 5000 tons of methane, 700 tons of ethylene, 2300 tons of carbon monoxide and approximately 1200 tons of hydrogen, and the separation of these should be carried out at convenient centres. In this connection reference is made to the Hypersorption process used in the U.S., in which olefines are removed from refinery gas by counter-current contact with activated charcoal, at a processing cost of 4·24 cents per U.S. gal of C3 and C4 olefines recovered in a plant costing $20,000 and handling 4 million cu ft of refinery gas per diem. C. L. G.

## Coal, Shale and Peat.

**210. New I.C.I. Works for Tees-side. Heavy Organic Chemicals to be Made.** Anon. *Chem. Tr. J.*, 14.12.45, **117**, 674.—Imperial Chemical Industries, Ltd., have recently acquired a 3500-acre site near Middlesbrough, and propose to develop this for the large-scale production of heavy organic chemicals from coal and oil, a capital expenditure of £10,000,000 being involved. In addition, it is proposed to construct a sulphuric-acid plant, an electrolytic chlorine-caustic soda plant, and a vacuum salt plant. The site is adjacent to a supply of salt, while cooling water will be available from the Tees estuary. Deep-water docks within a mile of the site are proposed.
C. L. G.

**211. Shale Oil Production and Recovery.** Anon. *World Petrol*, Sept. 1945, **16** (10), 80.—The U.S. Bureau of Mines is exploring the deposits of oil shale in the Rocky Mountain region, the greater part being in western Colorado, southwestern Wyoming, and eastern Utah, with an assay value of from 15 to 60 gal of crude oil per ton, amounting to 92 billion brl of recoverable oil. This is sufficient for 50 years—about four times as long as present proved petroleum reserves. A plant to process 200 tons of oil shale per day is to be constructed at Rifle, Colorado, at a cost of $1,500,000; together with a research laboratory at Laramie, to cost about $500,000.

The laboratory will develop a commercial process for recovery and refining of the oil from shale, and of by-products.

The Bureau's work is part of a 5-year programme for which $30,000,000 was authorized.

A new continuous retorting process, employing counter-current flow, has been developed by the Socony-Vacuum Oil Co., and placed at the Bureau's disposal. The crushed shale is passed down a tower, counter-current to a stream of heating gases which raises the temperature to 1000° F. Vapours are taken off at top of tower and condensed. Mining and crushing will cost $2.20 per ton, and experimental yields were from 17 to 40 gal/ton, the crude shale oil being very waxy, highly unsaturated, with high sulphur and nitrogen content. G. A. C.

## Miscellaneous Products.

**212. Polyvinylpyrrolidone.** Anon. *Mod. Plastics*, Nov. 1945, **23** (3), 157.—At a meeting of the Plastics Committee in Ludwigshafen on November 10, 1943, Dr. Fikentscher and Dr. Herrle of the I.G. Farbenind. A.G. reported on the development of polyvinylpyrrolidone, a soluble plastic used in a 2·5% solution as a blood plasma substitute (Periston) for transfusion. Vinylpyrrolidone is prepared by the Reppe synthesis from acetylene and formaldehyde via butinediol, butanediol, and pyrrolidone. It is readily polymerized with hydrogen peroxide on heating to 110° C, the toxic monomer being removed from the polymer by ether extraction. The conditions

of polymerization and the properties of the product have been studied in detail. The aqueous solution is neutral, stable without refrigeration, and is compatible with all blood groups. Solutions of the polymer are also used as bonding agents, thickeners, and sizing agents (Kollidon). They may be cross linked with di*iso*cyanates to produce water-insoluble polymers. C. L. G.

**213. Acetylene Industry in Wartime Germany.** R. L. Hasche. *Chem. Met. Eng.*, 1945, **52**, 116.—Owing to the lack of petroleum reserves and carbohydrate material, the Germans built up a very large acetylene industry during the war. The gas was prepared from calcium carbide as well as by the electric arc, and was used in the manufacture of butadiene, ethylene, vinyl compounds, monomeric acrylonitrile, as well as other intermediates in the plastic industry. Comprehensive tables show the extent of the acetylene industry in relation to the production of ethylene, solvents, synthetic rubber and fibres, and plastics generally. L. B.

**214. Efficacy of D.D.T. in Soap.** G. A. Campbell, F. C. Hymas, and T. F. West. *Nature*, 22.12.45, **156** (3973), 749.—It has been found that fleas and lice on dogs are killed by washing with household soap into which D.D.T. has been milled, and that reinfestation, even when eggs are present, does not occur for up to three months. The amount of D.D.T. deposited on the hair was estimated at 0·05–0·07%, as compared with the concentration on fabrics (0·01%) active against lice. There must therefore be a smilar absorption on the surface of the hair which withstands washing off with the soap. C. L. G.

**215. Optical Glass Substitute.** Anon. *Brit. Plastics*, Dec. 1945, **17** (199), 528.—The Polaroid Corpn of Cambridge, Mass., have developed a process for the manufacture of high-precision optical plastic elements, based on moulding in precisely surfaced glass moulds. After baking, the elements require no further treatment, reproducing the glass surface accurately. Two types of polymers have been standardized for this purpose: poly*cyclo*hexylmethacrylate, which corresponds optically to crown glass, and polystyrene, which corresponds to flint glass. Lenses made from these materials are more easily scratched than glass, but are lighter, and easy to produce in large quantities. They are stable under extremes of temperature, and are tough and substantially free from colour, haze, and strain. C. L. G.

## MISCELLANEOUS.

**216. Uses in Petroleum Industry for Uranium Atom.** R. E. Fearon. *Refiner*, Oct. 1945, **24** (10), 401–404.—After discussing the general physics of nuclear fission, the author discusses the use of radioactivity as a chemical tracer in refining and production, in identification of geological samples, in testing pipelines, and in its use to generated chemical reactions. A. H. N.

**217. Petroleum *vs.* Plutonium.** C. Goodman. *Oil Gas J.*, 17.10.45, **44** (28), 227.—This article considers the possible effects of atomic energy on the petroleum industry.

A description is given of the fundamental principles underlying the release of energy by nuclear fission, and the meaning of some of the specialized terms used is explained with reference to the periodic table. The four most successful methods of separating the isotopes of uranium (thermal diffusion, gaseous diffusion, centrifugal and electro magnetic) are explained, and the mechanism of the preparation of plutonium from uranium by the graphite pile is given.

In order to utilize the heat generated by the graphite pile for industrial purposes, it would be necessary to operate it at temperatures comparable with those of modern steam plants, and the problems inherent in this transition are shown to be very large. It is stated, however, that if developments are allowed to flourish unhampered by military restrictions and Government controls, these problems may be solved in a reasonably short time, and atomic energy may be available within the next decade. Whether atomic power will then be able to compete with petroleum, coal, and water power on an economic basis involves too many unknowns, and allows only speculation, but the answer will probably not be clear-cut.

Natural uranium and graphite piles are far too bulky to be used in units for mobile power, but the size of the pile might be diminished by using uranium enriched with U235 or to which plutonium has been added. The use of heavy water as a moderator instead of graphite would also allow substantial reduction in size. With decrease in size of power units, competition might begin with petroleum in replacing fuel oil in large sea-going vessels. Refuelling in such cases would be very infrequent, and the fire hazard would be completely absent. The shielding of the radioactive emanation would be a very major problem, and would add considerably to the size and weight of such units. In order to compete seriously with diesel oil and gasoline, atomic engines would have to be adaptable to trains, planes, commercial vehicles, and motor-cars.

It is pointed out that most of the considerations outlined above have been limited to the production of atomic energy by the nuclear fission of heavy elements. The consolidation of light elements into those of medium weight, however, releases comparable amounts of energy, although such nuclear synthesis have never been attained on a large scale. If future research achieves the production of atomic energy by such a means, many of the above limitations may be removed, and it is probable that the light elements used would be more plentiful than the relatively scarce fissionable uranium and thorium.

It is concluded that petroleum and coal will probably continue for at least another generation as primary sources of energy, and will generate most of the electricity during the next 50 years. Atomic energy may enter as a competitor, but its most extensive applications will probably be in new fields of human endeavour, such as production of extremely high temperatures and high speeds, production of radioactive substances for industrial and medical purposes, and the treatment of materials by radiation.

The author points out finally that when petroleum reserves are exhausted there will probably be ample atomic energy available, but that before this occurs petroleum will have ceased to be used mainly for fuel, and will have become the main raw material for organic chemicals. T. M. B. M.

**218. Postwar Inventories of Crude Oil and Petroleum Products in the United States.** A. J. McIntosh. *Petrol. Tech.*, May 1945, **8** (3), *A.I.M.M.E. Tech. Pub.* No. 1870, 1–13.—Petroleum consumption will undoubtedly decline temporarily after V-J day, and therefore the oil industry is urged to use this period as a favourable time for rebuilding its war-depleted inventories, thereby helping to cushion the effect of this decline on producers and refiners. Higher inventories should be re-established, since recent experiences have indicated that, by and large, the present inventories of crude are too low, even with the tremendous current production available. Analyses of inventories in earlier years indicates that inventory levels could be built up to about 490,000,000 brl by the end of 1947, an increase of about 40,000,000 brl over the stock estimated for the war's end. The dates are taken on the assumption that 1947 will be the first complete post-war year. If at the end of the war the military have some 20,000,000 brl on hand, this inventory will either be re-sold to the industry or certain demands that have been assumed to be met by industry will be supplied out of these military stocks, which would leave about 20,000,000 brl (net) to be built up from current production. For stock rebuilding the industry could use 10,000,000 brl of crude, plus 10,000,000 brl of products. Spread over a year this would mean 55,000 brl/day.

Tables give the average inventories held in a year and the total quantity of goods handled during the year, and indicate how far the inventories should increase in the immediate post-war period. The tables deal with crude, total refined products, gasoline, kerosine, distillate and residual fuel oils, and other products, for the East Coast, Gulf Coast and Inland Districts, California, and the whole of U.S.A.

G. D. H.

# BOOKS RECEIVED.

**An Outline of the History of the Academy of Sciences. Technical Sciences.** (In Russian.) Moscow–Leningrad: Academy of Sciences of the U.S.S.R., 1945. Pp. 68.

This pamphlet, issued on the occasion of the celebration of the 220th anniversary of the foundation of the Academy of Sciences of the U.S.S.R., gives a brief account of the technological work sponsored by the Academy since its commencement. Most of the space is devoted to work carried out after the Revolution, divided into 13 sections, dealing with various branches of applied science. In the section dealing with combustible minerals a couple of pages are devoted to a listing of some of the work on petroleum technology carried out by Russian scientists working in this field.

**Twenty-Five Years of Soviet Technology.** (In Russian.) Moscow–Leningrad: Academy of Sciences of the U.S.S.R., 1945. Pp. 208.

This volume consists of a collection of lectures made by various members of the Academy on the occasion of the celebration of the 25th anniversary of the Revolution, in 1942. The book is divided into five main sections, dealing with the following branches of technology: Mechanics, Machine Construction and Automatic Equipment; Energetics (Electricity, Gas and Steam); Metallurgy; Mining and Petroleum Industries; Transport.

The section dealing with the petroleum industry (23 pp.) is an account of the development of the industry in the period under review, with particular reference to oilfield development and crude-oil production; refining and transport of petroleum are but briefly mentioned.

**A.S.T.M. Standards on Petroleum Products and Lubricants.** Philadelphia, Pa., 1945. Pp. 530 + x. $2.75. Obtainable also from The Institute of Petroleum, 14*s.* 6*d.* post free.

This latest compilation of A.S.T.M. Standards on Petroleum Products and Lubricants brings together in convenient form over 80 specifications, tests, and definitions that have been standardized through the work of Committee D-2 on Petroleum Products and Lubricants.

In addition to the current report of the committee, there are several appendices covering the following: results of tests on method for estimating maximum pour points of lubricating oils containing pour point depressants, and two proposed methods covering a test for maximum pour point and total olefinic and aromatic hydrocarbons in gasoline.

The specifications cover cut-back asphalts—rapid and medium curing type, emulsified asphalts (five types), petroleum spirits, Stoddard solvent, thermometers, fuel oils, gasoline, etc.

The large number of test methods provide authoritative procedures for determining properties of a wide range of petroleum products, for example, acid heat of gasoline, aniline point, ash content, autogenous ignition temperatures, aromatics, olefins, benzene and *iso*pentane insolubles, crankcase oils, knock characteristics of fuels, specific gravity, colour, distillation, melting point, viscosity–temperature charts (Saybolt and kinematic), etc.

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# Oilfield Exploration and Exploitation.

## Geology.

**219. Rangely, One-time Shallow Field, now Rocky Mountains' Most Active Area.** C. R. Thomas. *Oil Gas J.*, 24.11.45, **44** (29), 90.—The Rangely field lies near the crest of the northwest-trending Rangely anticline. The southwest flank dips at 13–21°, and the northeast flank at lower angles. Northeast-trending faults cross the crest. The shallow oil occurrence is controlled by fracture zones in the Mancos (Cretaceous) shale. Regular production from the Weber (Pennsylvanian) sandstone began in 1943.

The field was discovered in 1902, but production became important only in 1919. The Mancos shale wells had initial outputs ranging from a few to more than 100 brl./day. A few deeper wells may have yielded gas from the Dakota sandstone, but they were soon flooded. In 1933 a well penetrated about 1500 ft into the Pennsylvanian, gas having been indicated in the Morrison and in the Nugget sandstone; oil was obtained in the Weber sandstone at depths of 5704–6320 ft. 13 Weber sandstone producers have now been completed, their outputs ranging 100–400 brl/day. Pressures are 2200–2300 lb/sq. in, and the g.o.r. averages 300–350 cu. ft/brl.

Between 1919 and 1938 the production ranged 10,000–33,000 brl/year, and in 1944 it was slightly under 400,000 brl/year. The Mancos shale oil is of 42° A.P.I. gravity, and that of the Weber sandstone is 33°.

The lower part of the Mesaverde formation is present, and consists of interbedded sandstone and shale, with a few coal-beds. The upper part of the underlying Mancos outcrops, and is made up of grey calcareous shale with a few beds of sandstone and concretionary sandy limestones. The Mesaverde forms scarps round the crest of the anticline, which is 20 ml long and 8 ml wide, with structural closure exceeding 1900 ft.

The Mancos shale oil appears to be in porous parts of calcite veins or in crevices in the fractured shale near the veins.

Recent drilling has revealed possibilities of new producing horizons in the Dakota and Morrison sands. Morrison sand production may be irregular. Water has not been found in the Weber. About 1000 ft of Pennsylvanian rocks and 500 ft of Mississippian and Devonian rocks have yet to be tested. Parts of the Morgan formation afford possibilities as source and reservoir rocks. The Madison limestone produces elsewhere.

G. D. H.

**220. New Zone in Wilmington May Increase Reserve 25,000,000 brl.** L. P. Stockman. *Oil Gas J.*, 3.11.45, **44** (26), 62.—The Wilmington field of California has produced 275,000,000 brl of oil and has a reserve conservatively estimated at 350,000,000 brl. The new zone is about 450 ft below the base of the Ford zone, and the first well gave 415 brl/day of 30·8°-gravity oil. This zone is known to occur in Blocks 2 and 3, but a well in Block 4 missed it.

The Wilmington field is divided into blocks by faulting, and, since there is no migration across the faults, the sectors can be developed independently. The structure as a whole is a northwest-plunging anticlinal nose. In the most easterly block only the Ranger is productive; in the most westerly area, Block 1, the Ranger and Ford are productive, the latter zone being relatively thin and of low porosity and permeability. In all there are seven producing zones: tar sand, Ranger, Upper Terminal, Lower Terminal, Union Pacific, Ford, and the new zone.

A substantial part of the highly productive Long Beach Harbour block extends southeast under the Pacific. The structure rises under the sea, and much oil may be out of reach beyond the area which can be drained by directionally-drilled wells. At present Wilmington produces about 100,000 brl/day. G. D. H.

**221. Exploratory Drilling in September.** Anon. *Oil Wkly*, 5.11.45, **119** (10), 34.—During September exploratory wells in U.S.A. were completed at the rate of 88·3/week, the weekly average for the first nine months of 1945 being 83·4. 21% of the September completions were successful; in the first nine months of 1945 the successes were 18·5% of the exploratory completions. During September 34 new oilfields and 11 new oil-pays were discovered, in addition to two new distillate fields and one new

distillate pay, and 10 new gas-fields. Extensions were made to 14 oilfields and two gas-fields.

Ellenburger production has been found in the Penrose-Skelly field, Lea County, New Mexico.

The September discoveries are listed with pertinent data, while tables summarize the exploratory drilling results by States and districts, and according to types of discovery. G. D. H.

222. **Exploratory Drilling Declines in October.** Anon. *Oil Wkly*, 26.11.45, **119** (13), 54.—U.S. exploratory completions in October averaged 80·8 per week, compared with 86·5 per week in September. 13·9% of the October completions were successful, and 21·4% of the September completions. The percentage of successes during the first ten months of 1945 was 18·1.

The October discoveries are listed with pertinent data, and tables summarize the wildcat completion results during October and during the first ten months of 1945. G. D. H.

223. **Gas-distillate Well Discovered in Mexico.** Anon. *Oil Wkly*, 12.11.45, **119** (11), 110.—A new gas-distillate producing area has been opened in northeastern Mexico across the Rio Grande from Lopeno, southern Zapata County, Texas. The well gave 100 brl of distillate and 20 million cu. ft of gas/day from the Wilcox at 5100 ft. G. D. H.

224. **Anzoategui Test May Open New Field in Anzoategui.** Anon. *Oil Wkly*, 12.11.45, **119** (11), 110.—La Ceiba 1 in northeastern Anzoategui has reached a depth of 8150 ft, and has cored a sand 75 ft thick with definite signs of oil saturation. Shows have been tested higher, but no production was found. G. D. H.

225. **Shell's Colombian Wildcat Reports Shows.** Anon. *Oil Gas J.*, 17.11.45, **44** (28), 168.—2 San Martin in the Llanos region is reported to have shown low-gravity oil in a drill-stem test of the Tertiary at a depth of about 6560 ft. G. D. H.

226. **Three New Wildcats in Colombia Bring to 23 Number of Rigs Now Being Run.** Anon. *Oil Wkly*, 26.11.45, **119** (13), 67.—Recently the wildcat Caraballo 1 was spudded south of Barranquilla, and El Pedral 1 was started across the Magdalena from Socony-Vacuum's Cantagallo concession. Velazquez 1 is to be drilled in western Boyaca.

A well on the Floresanto concession in the Department of Bolivar in extreme northwest Colombia was being tested. Its depth is 6936 ft. The well had a show at 630 ft. G. D. H.

227. **Extensive Field Activities Seen as Company Explores Remote Barinas Area.** G. O. Ives. *Oil Wkly*, 5.11.45, **119** (10), 54.—The Socony-Vacuum Oil Co. holds concessions over 1,300,000 hectares in the State of Barinas, Venezuela. San Vicente 1, a stratigraphic test in the central part of the State, went to 7000 ft. San Silvestre 1 has reached 7955 ft, and will investigate the whole of the Miocene and Eocene. Yaure 1 is to be drilled in the extreme west of Barinas. G. D. H.

## Geophysics and Geochemical Prospecting.

228. **Airplanes and Submarines may be Used in Search for Oil.** Anon. *Oil Gas J.*, 20.10.45, **44** (24), 94.—The U.S. Geological Survey has been asked to make recommendations for a survey of the continental shelf off the U.S. coast, covering an area of over 750,000 sq. ml. Under-water structures can now be located accurately, and drilling methods can be adapted to tapping under-water oil reserves. Seismic surveys can now be carried out in submerged areas, one survey having extended 26 ml off the Louisiana coast. Magnetic surveys can be made rapidly by aeroplane, while it has been suggested that gravimetric surveys can be made on the sea-floor by submarines in order to locate salt domes. Reflection and refraction seismic surveys could be made from boats and barges with instruments on the sea-floor in order, respectively, to locate deep and shallow salt domes, and even other structures.

The continental shelf in the Gulf of Mexico offers greatest present promise of oil-bearing structures; the shelf off the Pacific coast also is favourable, and there are indications that oil might be found off Alaska. Oil-bearing strata may extend into the Gulf of Mexico. G. D. H.

## Drilling.

**229. Unitized Mobilized Drilling.** K. B. Barnes. *Oil Gas J.*, 10.11.45, **44** (27), 76.—A portable drilling unit fitted on wheels is described and illustrated. A. H. N.

**230. Venezuela Deep Well Offers Valuable Data.** G. O. Ives. *Oil Wkly.*, 19.11.45, **119** (12), 32–33.—The drilling of a 13,034-ft well in Venezuela for the double purpose of training drilling crews in deepwell drilling and of ascertaining the stratigraphy of the field is described briefly. A. H. N.

## Production.

**231. Oil Migration.** J. Frost. *J. Inst. Petrol.*, Dec. 1945, **31** (264), 486–493.—Oil migration is divided into three phases. These are: (*a*) primary migration—*i.e.*, migration of oil from the source rock (usually a clay, but sometimes a limestone) into the reservoir rock, the reservoir rocks being those of high porosity and high permeability such as sands, sandstones, dolomites, etc.; (*b*) secondary migration—*i.e.*, the segregation of oil into pools within the reservoir rock; (*c*) tertiary migration or the dispersal of oil. These are discussed. A. H. N.

**232. Corrosion Inhibitor.** K. B. Barnes and C. J. Deegan. *Oil Gas J.*, 27.10.45, **44** (25), 84–86.—Corrosion of well pipes by hydrogen sulphide can be stopped by use of potassium cyanide, carbon monoxide, or formaldehyde. The first two gases are dangerous; formaldehyde is completely practicable. It is believed that savings of up to 2900% over the cost of treatment may be made. The grade used in stopping sulphide corrosion is the standard commercial product, available either in 55-gal drums or in tank-car lots, at prices f.o.b. plants of about 30 cents/gall in tank cars, somewhat higher in drum lots. The method of application in the field is simple. Measured quantities of standard commercial grade formaldehyde solution are injected into the annulus between the casing and tubing, through a simple drip-type lubricator. Initial injections, based on laboratory findings, were at the rate of 1 qt/day of formaldehyde per 25 brl daily production of salt water It was soon found that even this small quantity was more than was required. Present practice is to start with a daily injection of 1 qt of formaldehyde per 50 brl daily salt-water production, continue this for 30 days, then reduce to 1 qt per 100 brl daily salt-water production. A. H. N.

**233. Optimum Rate of Production.** Part 9. P. J. Jones. *Oil Gas J.*, 27.10.45, **44** (25), 109.—Other things equal, the optimum rate of producing oil depends on reserve, number of required wells, and operating expenses. Reserves, number of wells, and operating expenses are not completely independent of each other. The relationships among these variables depend on producing and operating methods. Producing methods determine whether oil will be displaced primarily by gas or primarily by water. Operating methods determine the location of wells relative to the source of gas or water. The difference between the reserve for displacement of oil by water and the reserve for displacement of oil by gas is illustrated by an example. If water is available, displacement of oil by water is likely to be a more profitable producing method than displacement of oil by gas. The volume of water required to achieve a desired oil recovery may be reduced significantly by providing sufficient distance between the source of water and producing wells. This point is illustrated by examples. The required distances can be provided under co-operative or unit operations. A. H. N.

**234. Optimum Rate of Production.** Part 11. P. J. Jones. *Oil Gas J.*, 10.11.45, **44** (27), 91.—Rates of production proportional to reserve are called uniform rates of depletion. A rate of depletion is equal to the rate of production divided by reserve. For uniform rates of production, the rate of depletion increases. Rates of production and cumulative recovery for uniform rates of depletion are illustrated by graphs and

examples. The present value of a reserve recoverable at rates of production proportional to reserve is easily estimated. This is one reason why uniform rates of depletion are important from the viewpoint of optimum producing rates. On the other hand, the present value of a reserve recoverable at uniform rates of production is higher than the present value of the same reserve recovered at declining rates of production. This is probably the chief reason why uniform rates of production are of interest from the viewpoint of optimum producing rates. A. H. N.

**235. Optimum Rate of Production.** Part 12. P. J. Jones. *Oil Gas J.*, 17.11.45, **44** (28), 279.—The present value of a reserve depends on the rate of recovery. The two rates of recovery of particular interest to producers are uniform rates of production and rates of production proportional to reserve. The latter represents uniform rates of depletion. The present value of a producing rate at any time is equal to the rate of production and the corresponding present worth factor. Present worth factors up to 25 years hence are illustrated graphically for interest rates ranging from 2% up to 10%. The present value of reserve recoverable at uniform rates of depletion is also illustrated graphically. The present value of a reserve partly recoverable at uniform rates of production and the remainder at uniform rates of depletion is illustrated by examples. The present values herein considered are before investment, taxes, royalty, and operating expenses. A. H. N.

**236. Pressure Maintenance by Water Injection.** W. L. Horner. *Oil Wkly*, 19.11.45, **119** (12), 28–31; *Oil Gas J.*, 17.11.45, **44** (28), 105. *Paper Presented before A.P.I.*—The operations of pressure maintenance by means of water injections are discussed. Data obtained at Midway disclose conclusive results, and confirm indications which were outlined before a meeting of the Division of Production of the Institute at Chicago, November 11, 1943. Since that date pressure, production, and cost records have been accumulated—which may be deemed of timely importance. The earlier publications referred to showed that injection into one well, located at the edge of a pool, 1800 acres in area, caused a marked decrease in the rate of pressure decline in the pool. Since then injection has been maintained in four wells, with the result that reservoir pressures have risen—although during the same period allowable and withdrawal rates have been increased substantially. The development of the field is described together with the pressure characteristics of the pool. The suitability of water injection for oil- and gas-pools is discussed, and is believed to be beyond the experimental stage. Although water-drive is widely advocated, there are important instances where gas-cap injection could prove more advantageous. Each pool requires study as early as possible. This would be facilitated first by drilling with wide spacing to define the pool boundaries, then by producing for a period at rates controlled to some extent by engineering requirements. This plan would provide suitable data for predicting results of various exploitation procedures. Thus, factual data will be made available early; and, if wide spacing is to be satisfactory under the procedure accepted, additional drilling can be avoided. A. H. N.

**237. Injection of Water into Underground Reservoirs in Michigan.** W. E. Shoeneck. *Oil Gas J.*, 17.11.45, **44** (28), 193. *Paper Presented before A.P.I.*—Injection of water in Michigan has been solely for the purpose of disposal, but regulations have been such that in excess of 90% of oil field waters are returned underground. The paper discusses the types of equipment used in injection wells and disposal systems, as well as describing the injection characteristics of each of the seven different formations employed for disposal purposes. Statistics on injection wells by years and by formations are detailed and summarized. A. H. N.

**238. Interactions between Interstitial and Injected Water—A Review.** A. J. W. Headlee. *Oil Gas J.*, 17.11.45, **44** (28), 219. *Paper Presented before A.P.I.*—An attempt has been made to present quantitative as well as the qualitative aspects of the problem of solids forming in oil and gas-field waters during recovery operations. The purpose is to develop, eventually, sufficient data in one paper so that a balance sheet can be made of the precipitates which may form in any operating system. Many quantitative data remain to be determined. The more common precipitates which form in recovery systems are carbonates, sulphates, sulphides, sulphur, iron

oxide, silicates, and organic residues. Although the quantity of these precipitates which may form is small, it is also true that the quantity necessary to cause serious plugging off of a well is quite small. In fact, a fraction of a pound of fine precipitate may cause a considerable decrease in the permeability of a well. The extent of the plugging-off effects will depend not only on the amount of precipitate formed, but also on its nature. The particles may be too large to enter the pores of the sand. Then, again, they may be small enough to circulate freely through the pores. A large amount of research work is necessary to complete the picture. It should be possible to obtain sufficient data to enable one to predict precipitation before it has a chance to lower the permeability of the sand. A. H. N.

**239. Behaviour of Water-Input Wells.** Part 1. P. A. Dickey and K. H. Andresen. *Oil Wkly*, 19.11.45, **119** (12), 38; *Oil Gas J.*, 17.11.45, **44** (28), 205. *Paper Presented before A.P.I.*—The hydrodynamics of flow through porous media are briefly discussed. Various aspects of the permeability of sands are analyzed. The radial flow into, or from, a well will follow the usual Muskat's formula until two or more wells begin to interfere with each other, when the intake rate of a well will be reduced. It may be assumed that the average intake rate during the time between interference and the complete filling of the pattern is the mean of the rate just prior to interference and the steady rate of the pattern. The time required to reach the steady rate can then be computed, using the additional volume of water which must be injected between interference and fill-up; and the curve can be interpolated. This is illustrated. A. H. N.

**240. Closed System of Intermittent Gas Lift Applied in Single-Well Operation.** E. H. Short, Jr. *Oil Gas J.*, 27.10.45, **44** (25), 113.—A 190 brl/day well is produced from 7110 ft by gas lift on 15-min cycles. The system is closed, the gas recycled through the aid of compressor. Consequently there is no need for outside high-pressure gas. A. H. N.

**241. Patents on Drilling and Production.** D. Silverman, assr to Stanolind Oil & Gas Co. U.S.P. 2,384,648, 11.9.45. Appl. 14.1.42. Locating bottom of oil production.

O. Hammer, assr to Security Engineering Co., Inc. U.S.P. 2,384,675, 11.9.45. Appl. 28.9.42. Apparatus for multiple stage cementing.

G. Herzog, assr to The Texas Co. U.S.P. 2,385,857, 2.10.45. Appl. 29.1.44. Cushioning device for radiation detectors.

M. De Groote and B. Keiser, assr to Petrolite Corpn., Ltd. U.S.P. 2,385,969, 2,385,970, 2.10.45. Appl. 9.4.43. Process for breaking petroleum emulsions.

R. Cross. U.S.P. 2,386,036, 2.10.45. Appl 6.9.43. Method for secondary recovery of oil.

G. R. Watson, assr to Bucyrus-Erie Co. U.S.P. 2,386,281, 9.10.45. Appl. 7.5.43. Tool-guide for cable tool-drills.

J. C. Stokes, assr to Reed Roller Bit Co. U.S.P. 2,386,514, 9.10.45. Appl. 11.6.42. Side-hole coring device.

W. P. Munk. U.S.P. 2,386,564, 9.10.45. Appl. 9.6.41. Oil and gas separator.

C. C. Carter, assr of 25% to C. T. Stewart. U.S.P. 2,386,593, 9.10.45. Appl. 18.4.42. Activator for wells.

E. E. Harton, Jr., and P. Lyon, assr to The Pure Oil Co. U.S.P. 2,386,605, 9.10.45. Appl. 15.10.43. Treatment of oil-wells.

E. F. Cooke, assr to Beaumont Iron Works Co. U.S.P. 2,386,841, 16.10.45. Appl. 7.10.41. Well completion apparatus.

C. E. Bannister. U.S.P. 2,387,002, 16.10.45. Appl. 24.6.42. Apparatus for cementing the wall of an earth boring.

C. H. Barnes, assr to Lane-Wells Co. U.S.P. 2,387,003, 16.10.45. Appl. 4.8.41. Double seal packer.

E. A. Stephenson, assr to The University of Kansas Research Foundation. U.S.P. 2,387,361, 23.10.45. Appl. 29.6.43. Method of treating oil-wells.

G. F. Wislicenus, assr to Worthington Pump and Machinery Corpn. U.S.P. 2,387,377, 23.10.45. Appl. 2.3.44. Deep-well pump.

J. S. McDonald and W. E. A. Ruska. U.S.P. 2,387,456, 23.10.45. Appl. 23.6.42. Controlling device for well tools.

C. A. Brokaw. U.S.P. 2,387,493, 23.10.45. Appl. 1.3.43. Means for cementing wells.

E. J. Roach and E. F. Cooke, Jr. U.S.P. 2,387,610, 23.10.45. Appl. 16.12.41. Well control head.

J. G. Richey. U.S.P. 2,387,682, 23.10.45. Appl. 1.9.42. Rotary jar and safety joint.

T. B. Wayne. U.S.P. 2,387,694, 23.10.45. Appl. 27.3.36. Treatment of drilling fluids.

V. F. Every, U.S.P. 287,725, 30.10.45. Appl. 28.1.44. Well-screen.

G. G. Harrington, assr to Reed Roller Bit Co. U.S.P. 2,388,141, 30.10.45. Appl. 4.1.43. Electrical logging apparatus.

M. C. Johnson. U.S.P. 2,388,416, 6.11.45. Appl. 17.9.43. Casing centring device.

T. F. Moore, U.S.P. 2,388,640, 6.11.45. Appl. 17.12.43. Well point.

R. R. Hays. U.S.P. 2,388,741, 13.11.45. Appl. 29.4.44. Hydraulic drilling device.

C. B. Aiken, assr to Schlumberger Well Surveying Corpn. U.S.P. 2,388,896, 13.11.45. Appl. 28.1.42. Electrical method and apparatus for logging boreholes.

J. G. Smylie. U.S.P. 2,388,938, 13.11.45. Appl. 31.8.44. Firing head for gun perforators.

W. P. Orr, assr to Standard Oil Development Co. U.S.P. 2,389,208, 20.11.45. Appl. 22.1.43. Side-wall sample-taking apparatus.

H. J. Woolslayer, E. A. Campbell and C. Jenkins, assr to L. C. Moore & Co. U.S.P. 2,389,226, 20.11.45. Appl. 10.4.44. Fast sheave mounting for oil-well masts.

D. Silverman, assr to Stanolind Oil & Gas Co. U.S.P. 2,389,241, 20.11.45. Appl. 26.4.44. Well logging.

G. A. Humason. U.S.P. 2,389,512, 20.11.45. Appl. 28.1.43. Tester for wells.

A. L. Armentrout. U.S.P. 2,389,710, 27.11.45. Appl. 12.8.41. Jarring tool.

A. L. Armentrout. U.S.P. 2,389,711, 27.11.45. Appl. 13.8.41. Well jar.

J. T. Phipps, assr to Vernon Tool Co. Ltd. U.S.P. 2,389,869, 27.11.45. Appl. 9.2.45. Locking and setting device.

G. E. Justice, F. M. Thurston and F. N. Young, assr to Houston Oil Field Material Co, Inc. U.S.P. 2,389,985, 27.11.45. Appl. 23.5.41. Retractable packer.

G. F. W.

## Oilfield Development.

**242. Summary of September Completions.** Anon. *Oil Gas J.*, 27.10.45, **44** (25), 170.—U.S.A. had 2640 completions during September. 1389 gave oil and 292 gave gas. A table summarizes the completion results by States and districts, and gives footages and numbers of wells in different depth ranges. G. D. H.

**243. Completions Show New Decline.** Anon. *Oil Wkly*, 19.11.45, **119** (12), 46.—During October wells were completed in U.S.A. at the rate of 499 per week, the lowest rate since May. In September the rate was 542 per week. It is likely that the 1945 total will be 25,600 wells. Wildcatting is expected to be continued intensively.

During the first ten months of 1945, 21,574 wells were completed, compared with 20,067 in the same period of 1944. The corresponding figures for Texas were respec-

tively 6146 and 5084. Louisiana had 38% more completions than in the first ten months of 1944.

A table summarizes the U.S. well-completion results during October and during the first ten months of 1945. G. D. H.

**244. Mexico's Oil Production Increases 20 per cent.** Anon. *Oil Gas J.*, 8.12.45, **44** (31), 66.—In the second quarter of 1945 Mexico produced 11,172,153 brl of crude, output in the first quarter being 9,361,728 brl. G. D. H.

**245. Worth of Las Mercedes Field may be Revealed Soon by Pipe-line Outlet.** Anon. *Oil Wkly*, 12.11.45, **119** (11), 110.—Las Mercedes 16, 14 km east and a little north of the proven field, has been completed at 6400 ft, where it had been testing for several weeks.

Las Mercedes 2 opened the field in 1941, being a dual completion with gas in one horizon and oil in another. A second producer was completed in 1943. 12 producers have been drilled and several pays established. Most wells are about 4600 ft. deep. A pipeline may be built in the near future. G. D. H.

**246. Pemex Plans Vigorous Exploration Programme.** L. J. Logan. *Oil Wkly*, 5.11.45, **119** (10), 43.—Pemex is employing 17 geological parties, 4 gravity, 6 seismic and one electrical party, and will increase the total to 36 in 1946. 30 exploratory and 45 development wells per year are planned, a doubling of the activity. The present production of 115,000 brl/day comes from 932 wells, 747 of which flow naturally. Since 1938, 315 million brl of oil have been produced. Within that period reserves have been added mainly by extensions and new pay-zones. The total known reserves have been stated to be 870 million brl, over 500 million brl of which apparently belong to Poza Rica. Since 1901 Mexico has produced nearly 2,200,000,000 brl of oil, mainly from a comparatively small developed area within a much greater area with good oil possibilities.

About a quarter of Mexico has geological conditions more or less favourable for oil occurrence. This area includes western Lower California, a coastal area in Sinaloa, and the coastal belt along the Gulf of Mexico. In northeastern Mexico five gas and gas-distillate areas have been found. Further tests are to be made there, for the area is believed to have oil possibilities. The Tampico-Tuxpan area has given 2000 million brl of oil, and includes the fields of the Panuco district, the Golden Lane and Poza Rica. Several wildcats are being drilled. West of the Golden Lane the Soledad discovery well was completed in June 1945. Shows have been logged at Castillo, also in the Tamabra limestone (Lower Cretaceous), which produces at Poza Rica. The Panuco area has numerous pools producing heavy oil from faults and fissures on a broad arch in the Tamaulipas limestone (Lower Cretaceous) under water drive. The cumulative production is 750 million brl and the reserves about 75 million brl. The Golden Lane pools extend for about 50 ml. The high-sulphur oil comes from highs on a narrow anticline, and from the El Abra (Lower Cretaceous) limestone. There is a very effective water drive. 20 ml to the south is the Poza Rica field, which produces from a porous patch of limestone of Lower Cretaceous age, on an anticlinal nose. This field covers about 14,000 acres. There is a very effective water drive.

The third major oil region covers the Yucatan Peninsula and the northern half of the Isthmus. The present fields are in the northern part of the latter area in a saline basin. They produced from Miocene sands on the tops and flanks of salt structures. About 30 salt structures are known; some have yet to be tested. Six have non-commercial production and five produce commercially. The salt-dome tops are irregular. No commercial production has been obtained from the cap-rocks. Some 125 million brls of oil have been produced, and the reserves are estimated at 50 million brl. Except for El Plan, the fields of the Isthmus are drilled up. Wildcats are being drilled on the La Venta and Tecuanapilla structures. G. D. H.

**247. Production Occurs in Two Coastal Areas.** Anon. *Oil Wkly*, 26.11.45, **119** (13), 38.—Mexican oil production is obtained from the Tampico-Tuxpan and the Isthmus of Tehuantepec areas. The Panuco fields are on the continuation of the Sierra Tamaulipas. Production began in 1904, and in 1938 527 wells were operating to give an average production of 20,000 brl/day. 54 wells have been drilled since 1938, slightly increasing the total productive capacity.

Out of 1055 wells drilled on the " Golden Lane " up to 1938, 527 were then productive, and averaged 23,160 brl/day. Since 1938 the production of the area has been irregular due to varying demands.

Between 1930 and 1938 18 wells were drilled in the Poza Rica field, and the maximum production was 64,705 brl/day. A total of 52 wells have been drilled. This is one of the world's largest fields.

On the Isthmus of Tehuantepec the fields are associated with salt domes. Production began in 1923. Most of the wells produce less than 100 brl/day, but those at El Plan were better producers, and in 1943 a deeper horizon with good possibilities was discovered at 6069 ft.

Out of 13 wildcats drilled between 1941 and mid-1945, two were producers. Mission 1 was completed in April 1945 for 6,000,000 cu. ft of gas and 45 brl of distillate/day, from 6040 ft. Mission 1 is near the Texas border. Soledad 1 was completed in July 1945. It lies west of the " Golden Lane," and gave 40 brl/day of 40-gravity oil from 6480 ft.

Maps show the location of the fields, and tables give the production in recent years, the tank-storage capacity at the various fields, and brief notes on the more recent wildcats. G. D. H.

**248. The Oil Situation in Colombia.** Anon. *Oil Wkly*, 5.11.45, **119** (10), 12.—In 1944 seven wildcats were completed in Colombia ; one found gas, and the rest were dry. Eight dry wildcats were completed in the first half of 1945 ; six wildcats were in progress at the end of July. The Casabe field has 30 producers, and the Dificil tract two shut-in oil wells and a gas-distillate well. On the east bank of the Magdalena opposite the Casabe field the Galan 1 wildcat has extended production into the De Mares concession. The initial output was 1200 brl/day. The Infantas and La Cira fields are almost completely drilled up.

Two dry wildcats were drilled on the Retiro concession before its abandonment. Four dry holes have been drilled on the La Dorada tract. Tests are to be drilled on the Caraballo and Pinto tracts. A wildcat will be drilled in extreme western Boyaca, and one near Barranquilla. It is reported that work will be carried out in Putumayo and Caqueta, near the Ecuador border.

The Socuavo dome is being systematically developed, and it is likely that a deep Cretaceous pay will be exploited in the whole Tibu area if a test on the Tres Bocas dome is successful. Moderate commercial production has been developed on the Cantagallo tract, west of Puerto Wilches. G. D. H.

**249. Crude Output in Argentina shows 5·9 Per Cent. Drop.** Anon. *Oil Gas J.*, 1.12.45, **44** (30), 50.—During the first quarter of 1945 private companies in Argentina produced 306,332 cu. m of oil, and Government wells produced 626,969 cu.m. G. D. H.

**250. Russia Expands.** W. B. Hill. *Oil Wkly*, 5.11.45, **119** (10), 3.—The utilization of natural gas is undergoing extensive expansion in Russia. Several important gas pipelines have been laid, and others are under construction or planned. The 500-ml 10- and 12-in line from Saratov to Moscow will have a capacity of 80 million cu. ft/day. Gas from the new Cherdin field, near Bereznovi, passes 400 ml to steel plants at Sverdlovsk. A 450-ml line from Daszawa to Kiev is planned. Kuibyshev is supplied from Buguruslan. In Central Asia Andizhan is connected to nearby oil- and gas-fields. Gas reserves have been found near Morshansk in the Moscow Basin, Western Urals, Penza region, Kalmyk Steppes, northern Caucasus, the Saratov–Volga districts, Kuban, and the Crimea. An oil pipeline is being built from the Ploesti area to Odessa, and one is to be built from Bacau to Odessa.

2000 geologists and geophysicists are at work with a view to establishing new reserves to meet further requirements. During the war new fields have been found in the Ural-Volga region, where, until mid-1944, the fields tapped Upper Palæozoic pays at depths of 1000 to over 3000 ft. At least 10 major fields were being developed in the Kuibyshev Combine area. Four promising fields were being developed in the Kama River valley. Two important fields were found at Ust Uchta and Izhma near the Arctic Circle, and they probably produce from the Palæozoic. At the beginning of the war the Ural–Volga region gave 45,000 brl/day ; at the beginning of 1945 the output

exceeded 225,000 brl/day. Late in 1944 a wildcat was completed at 9600 ft in the previously shallow field of Tuimazy, west of Ufa, giving oil from the Devonian.

A Devonian test midway between Syzran and Kuibyshev found oil at 8500 ft. Hopes are entertained that Devonian production will be found elsewhere, possibly in stratigraphic traps in some cases. Devonian production has been found near Molotov.

Buguruslan is the largest of seven new fields in Bashkiria, but the most important producer is Kinzebulatovo, near Ishembai, opened late in 1943.

In the Baku region wells have been drilled 4½ ml offshore, and seismic work has revealed two trends with closed areas offshore. Offshore wells are drilled from barges sunk on to piles. Further structures have been defined on land, and a new field has been opened near Maklach-Kala.

Deep drilling has opened excellent new pays in several old fields south and southeast of Samarkand. New fields have been discovered in the Fergana Valley. Drilling has been carried out in the Kazakh Republic, Yakutsk area, and the Kamchatka Peninsula.

Secondary recovery methods are to be applied in fields such as Grozny, Krasnokamsk, Krasnodar, and Kazakhstan. G. D. H.

**251. Egyptian Exploration being Conducted on Broadest Front in History.** C. O. Willson. *Oil Gas J.*, 1.12.45, **44** (30), 56.—Several geological parties are at work in Northern Egypt, and 4 wildcats are being drilled. At present the two producing fields, Hurghada and Ras Gharib, yield 26,000 brl/day, the former field contributing 1400 brl/day. In seven years Ras Gharib has produced about 40% of its initial reserve, estimated to have been about 110 million brl.

During the spring South Mediterranean Oilfields, Ltd., completed a dry hole at Khatatba, 25 ml northwest of Cairo. The company's interests are to be taken over by other companies.

Exploration for oil, and shallow drilling began in 1885 in the Gemsah area. The first producer in this area was completed in 1909, and the field had a small output until 1927. The Hurghada field was opened in 1913, and Ras Gharib in 1938. A test is being drilled 15 ml northwest of Ras Gharib. Another is under way 15 ml east of Suez, about 1½ ml from 1 Ayun-Musa, which was drilled to 5500 ft and ultimately completed as a shallow water well. A test is to be drilled near Ras Metarma. Eight tests have been drilled in the Ras Shukhair and Desht-el-Daba area. Six have been drilled north of Ras Gharib.

The Gulf of Suez and the Red Sea area is geologically a zone of subsidence, dating from the Miocene. Large amounts of gypsum, anhydrite, rock salt, dolomite, and in places globigerina marls were deposited. Asymmetrical fault blocks are the main structures. At Ras Gharib the Miocene rests on Cretaceous and Carboniferous, the latter beds giving the bulk of the production.

Two tests have been drilled in North Sinai, and a third is under way. The El-Nekhl test, 70 ml east of Suez, was abandoned at 5566 ft. Darag 1, 6 ml to the southeast, was drilled to 2768 ft. 1 Abu Samth lies 5 ml northwest of the Nekhl well. 1 Khabra is to be drilled 6 ml from the Palestine border.

North Sinai represents the southwestern continuation of the Syrian-Palestine belt. Jurassic beds are well developed and there are great asymmetrical anticlinal uplifts which have been surveyed gravimetrically and seismically.

In the Western Desert province many exploration permits have been taken out, but very little drilling has been done. The Leon well near Mersa Matruh went to 2000 ft, the Daba well to 6000 ft, and the Khatatba well to 7000 ft. All were dry. Oligocene, Miocene, and Pliocene beds are exposed, but many areas are covered by wind-blown sand and alluvium, calling for geophysical exploration. Near Giza Lower Cretaceous and Upper Eocene outcrop.

In the Eastern Desert there is a well-exposed Tertiary area, with one or two small Cretaceous inliers.

Brief notes are given on the regulations covering oil exploration, and a map shows the areas taken up under exploration permits. G. D. H.

**252. Oil Production in Egypt comes from Two Fields on Suez Gulf Shores.** C. O. Willson. *Oil Gas J.*, 8.12.45, **44** (31), 62.—Anglo-Egyptian Oilfields, Ltd., first found production in 1908, in Gemsah No. 1, on the west coast of the Gulf of Suez between

Ras Gharib and Hurghada. 22 wells were drilled, 10 being producers, and in 16 years from 1911 the cumulative output was 1,300,000 brl. Hurghada was discovered in 1913, and during 32 years it has produced 40 million brl. The present output is 1400 brl/day, of 22–24° A.P.I. oil. Oil occurs in the Nubian sandstone, lying unconformably below the Miocene, at depths of 1700–2200 ft. The current output is 93% water.

Ras Gharib has produced 45 million brl, and has remaining reserves estimated at 55 million brl. The field was opened in 1938, and for some time has averaged 24,000 brl/day. This rate is undoubtedly too high for efficient operation. In 1921 and 1923 two dry holes were drilled a little to the south of the present field. Work was renewed in 1937 after a gravity-meter survey, and the first well was completed at a depth of 2560 ft. The section shows 700–1000 ft of sands and grits, underlain by 1000 ft of anhydrite and shale, with local limestone development which shows signs of giving a small settled production. These Miocene beds rest unconformably on Cretaceous and Carboniferous, the former having minor sand bodies with small oil production, and the latter providing the main oil output. There is an easterly-dipping monocline of pre-Miocene beds faulted on the west and south, with a covering dome of Miocene which is also affected by the main faults. Oil trapping in the upper Carboniferous sands is by the nonconformity, and in the lower sands by non-conformity and faulting.

Drilling is done by diesel-powered rigs. Rock bits are used extensively, and lost circulation causes trouble at 300–700 ft. At present there are 26 flowing wells, 13 gas-lift wells, and 42 pumping wells. The field is under hydrostatic control, with no gas-cap. Part of the production requires dehydration.

A wildcat is being drilled 15 ml north of Ras Gharib, and one 15 ml east of Suez and 1½ ml east of the large Ayun-Musa water well.

The Suez refinery includes skimming and cracking plants. G. D. H.

**253. Bahrein Island Produces 20,000 brl and Refines 70,000 brl/day.** C. O. Willson. *Oil Gas J.*, 20.10.45, **44** (24), 110.—The Bahrein Island discovery well was completed in 1932, and 74 producers have been drilled to outline a structure 7½ ml long and 2½ ml wide. The axis of the structure runs north–south. Dips range 3½–6°. There is no evidence of faulting. Oil is obtained from three pays, and their aggregate producing thickness is 500 ft. The first and second pays lie 1800–2200 ft deep. The initial reservoir pressure was about 1200 lb/sq. in, and the oil is undersaturated with gas, its bubble-point being 250–350 lb/sq. in. There is an active water drive. Several years ago it was found that the water advances did not maintain the pressure when the optimum production rate of 20,000 brl/day was used, and the injection of gas was begun to balance oil withdrawal against water advance, and so maintain pressure. In the deeper horizon several of the thick limestone members contain dry gas, while others have a large gas-cap area and a narrow ring of black oil. The dry gas is at 2100 lb/sq. in, and is used directly for injection into the first and second pays.

The refinery at Awali processes 70,000 brl/day, 50,000 brl/day of oil being obtained from the mainland of Saudi Arabia. The main equipment includes two low-pressure atmospheric tower crude-oil distillation plants; one low-pressure atmospheric and vacuum tower crude-oil distillation unit; one fluid-type catalytic cracking plant; two thermal re-forming plants; two thermal cracking plants; one thermal gas-recovery plant; one fluid-type isomerization plant; one sulphuric-acid-type alkylation plant. These plants are briefly described. G. D. H.

**254. Saudi Arabian Petroleum Operations are Rapidly Reaching Major Proportions.** C. O. Willson. *Oil Gas J.*, 3.11.45, **44** (26), 70.—The Arabian American Oil Co. has concession rights over an area of 611,200 sq. ml in Saudi Arabia. The first producer in the Dammam field was completed in 1936 at a depth of 2109 ft. It was soon discovered that this sand would not support commercial oil development, and deeper exploration gave a large well at a depth of 4727 ft, in 1938. This well produces 2500 brl/day, and has given over 4,200,000 brl. 23 wells have been completed in this, the Arab zone, and have proved an area 5 ml by 4 ml. They yield 70,000 brl/day, the oil passing to the Bahrein and Ras Tanura refineries.

The discovery well of the Abu Hadriya field was completed in 1940 at a depth of 10,200 ft. It lies 100 ml northwest of Dammam. This is believed to be a major reserve. Abqaiq is the largest field, and was opened in 1941. The first well was completed at 6180 ft, in the D member of the Arab zone. It lies 50 ml southwest of

Dammam. The A and B members are wet, the C member gives 30°-gravity oil, and the D member 37–39°-gravity oil. Five wells have been completed in the field which is at least 7 ml long and 3 ml wide, the limits not having been defined in any direction. A 14-in pipeline to Dammam will be built. The discovery well of the Qatif field was completed in the C and D zones of the Arab zone at 7360 ft. The field is 22 ml north and a little west of Dammam.

The western part of Saudi Arabia consists of pre-Cambrian crystalline rocks which topographically and probably structurally slope gently northeast, east and southeast. The eastern areas are covered by gently-dipping sediments which include early Palæozoic, and exceptionally complete representation of the Mesozoic. To the east are Tertiary and later deposits. The eastern part of the Nejd area west of the province of Hasa where the present production is found consists of a series of sediments ranging in age from early Palæozoic to Lower Eocene. In Hasa the exposure consist of Lower and Middle Eocene and Mio-Pliocene, with subordinate Pleistocene. The Eocene is almost wholly calcareous; the Mio-Pliocene is generally continental, only slightly disturbed and masking the underlying structures. The rocks overlying the Arab zone are Lower Cretaceous. In the coastal area of Hasa the monocline is disturbed by low domes such as those of Dammam, Abqaiq, and Abu Hadriya. Bahrein and the producing structures of Qatar are similarly placed. All the Saudi Arabian production is from limestones. The most extensive and highly productive facies of the Arab zone is a slightly cemented oolite.

Saudi Arabia and Bahrein are estimated to have proved reserves of 2000 million brl, a figure which recent developments have probably made most inadequate.

In some cases two horizons are produced together; in others dual completions are made. Lost circulation is a serious problem in drilling. The crude passes through two separators, and then through gas-traps to a weathering column. The vapour from the weathering operation passes to the stage gas compressors and then to the gas rectifier. This operation completes the stabilization of the crude, and gives a maximum recovery of light hydrocarbons.

A small refinery is operated at Ras Tanura, and is designed to give maximum yields of diesel and fuel oils. There will be two 25,000-brl units providing for atmospheric and vacuum fractionation, and two 7000-brl re-forming units. G. D. H.

**255. Plans Under Way to make Qatar a Major Source of Petroleum.** C. O. Willson. *Oil Gas J.*, 15.12.45, **44** (32).—The first exploratory test (1 Dukhan) on the Qatar Peninsula was begun in 1938, and completed in limestone in 1940, with an initial output estimated at 5000 brl/day of 36° A.P.I. oil. 2 Dukhan completed 10 ml to the south in 1941 had a similar production. On deepening gas production was obtained at 6206 ft. 3 Dukhan, 2½ ml east of 1 Dukhan, was in edge-water. Threat of invasion caused the wells to be plugged.

Production is from a Mesozoic limestone on a north–south anticline, which is 4½–5 ml wide and possibly 50 ml long in the surface beds. The subsurface structure is smaller. No. 1 and No. 2 limestones in the Zekrit formation are thin and barren; No. 3 is about 100 ft thick, and gave oil in the first two wells and water in the third. The No. 4 limestone is 330 ft deeper, giving gas in 2 Dukhan and water in 3 Dukhan.

Drilling is difficult. A water-string is set at about 4000 ft, and wells are completed with an 8¾-in string cemented at the top of the producing horizon, the wells producing from open hole after drilling in. G. D. H.

**256. Oil Production Resumes on Tarakan.** Anon. *Oil Gas J.*, 8.12 45, **44** (31), 66.—Oil production on a limited scale has been resumed on Tarakan. In 1940 and 1941 the output was, respectively, 807,821 and 698,284 tons.

On invasion in 1942 most of the wells were destroyed. When the Allies invaded in 1945 the Japanese had failed to destroy one-third of the wells in the Pamusian area, and almost half the wells drilled by the Japanese were in working order. The Japanese drilled 140 wells. G. D. H.

## Transport and Storage.

**257. Design of Oil Pipelines.** Part 3. F. Karge. *Petrol. Engr*, May 1945, **16** (8), 76.—Design and heat loss calculations are discussed and Gill's chart for the temperature

drop of hot oil in pipes is given. Plotting the temperature gradient over the pipeline length, the viscosity at the mean temperature of the successive sections, and the progressive sums of the pressure drops against the length of the line will show irregularities in the calculations. Flow in most heavy heated oil lines passes through the so-called unsteady region between the upper and lower critical limits, and it is shown how much the calculated pressure drop will increase by following the turbulent flow factor curve to the lower critical limit. Discussion of the Docksey " S " transition curve is made, and it is recommended that an investigation be made on the above lines to determine the distance between the critical limits and the pressure drop, through this distance, for the friction factors along the turbulent and streamline flow curves. It is probably safe to use an intermediate value between the two.

Heavy oils must always be pumped fast to prevent the line freezing, especially in winter. It is advisable always to determine the temperature gradient and pressure drop for a smaller flow than the designed rate. If operations do not allow continuity, to prevent blocking of the line, the following action can be taken: (1) displacement by lighter oil, if available, and the line warmed up by displacing the light oil, with heated light oil before pumping the heavy oil; (2) the line can be kept fluid by pumping hot oil back and forth during the shutdown period; (3) hot water can also be used for the purpose.

Tapering a line means a larger-diameter pipe is laid down for the unsteady and streamline portion of the line; such tapering has proved very satisfactory, and has the advantage that lighter pipes can be used as the pressure is lower. A graph is given showing temperature-pressure gradients for 1500 brl/hour, Santa Maria crude oil. From such graphs it is shown how easily the location, length, and size of the larger pipe (the tapered section) can be found by simply drawing in two triangles and reading the points of intersection. The subject is discussed and a problem is solved. Heaters, pumps, and yearly costs of operations are briefly surveyed and discussed. Special problems are also reviewed. When a line becomes too small, the question whether to replace it by a larger one or parallel it with a line of equal or different size becomes an economic issue. Multiple lines are called loops. W. H. C.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**258. Peacetime Utility of Wartime Petroleum Refining Processes.** F. D. Parker. *Refiner*, Nov. 1945, **24** (11), 443–449. *Paper Presented before California Natural Gasoline Assoc.*—The utility of the war-built plants in the manufacture of peacetime refined products is of interest not only to the refiners who installed one or more of these units for the production of aviation gasoline, but also to those refiners who, through consideration of individual economic, geographical, or transportation factors, were not in a position to participate in the 100-octane programme, or phases of the toluene and synthetic-rubber programmes, and now find themselves entering the post-war period with pre-war refining facilities operating in competition with more modern facilities of other refiners. While the problem of what plants can be operated economically is one that must ultimately be reviewed by each individual refiner in the light of conditions peculiar to his situation, there are certain more or less general technico-economic considerations. The paper deals with this latter aspect of the problem. It is concluded that: (1) The most generally applicable refining tool commercialized during the war is catalytic cracking; (2) Thermal of catalytic polymerization of $C_3$ and $C_4$ unsaturates otherwise disposed of to fuel gas or low-priced liquefied petroleum gas is, as before the war, an economical operation for virtually all refiners conducting cracking operations; (3) Alkylation of $C_3$ and $C_4$ unsaturates and *iso*butane to the extent that they are available in excess of specification-vapour-pressure gasoline (and hence disposed of to low-priced fuel gas) is economical for large refiners and marginal for small refiners; (4) Isomerization of normal butane to *iso*butane for subsequent use in alkylation is justifiable economically only if field or refinery *iso*butane costs 1–2 cents/gallon more than normal butane, and alkylate produced therefrom is incremental, and hence of low unit cost; (5) Isomerization of normal pentane to *iso*pentane for octane improvement is economical only where suitable normal pentane charge can be easily

segregated (as from straight-run gasoline) and in relatively large capacity units; (6) Hydroforming, in the present stage of development, does not appear economically justifiable for upgrading octane of naphtha for motor fuel, but may be suitable for certain specialized operations such as aromatic chemical production.

A. H. N.

**259. Caribbean Refineries were Closely Geared to Allied War Operations.** Anon. *World Petrol.*, Nov. 1945, **16** (12), 62.—A review of the activities of refineries in the Caribbean area, which has made the largest contribution of oil from territories outside the United States; 700,000 brl of crude being processed daily towards the latter part of the war.

The largest of four plants operated by the Royal Dutch-Shell Group was at Curaçao, with a daily throughput of 300,000 brl; where a wide range of products, including substantial quantities of 87 octane and about 12,000 brl daily of 100-octane aviation gasoline were made.

A successful thermal cracking process, the Avaro, was developed to produce a highly aromatic aviation blending agent from a crude naphtha cut. This permitted a reduction in the total alkylate content of the 100 octane blend, and the incorporation of lower octane base stocks.

Plant for the production of cumene, and alkylation units were also developed.

United Kingdom requirements of high-quality tractor fuel were supplied from Curaçao. Large quantities of light fuel from Venezuelan crude for the Allied Navies were produced, which involved discarding some 11,000,000 brl of hard asphalt. A single refinery produced 5,000,000 brl of thin combat fuels monthly.

Substantial amounts of naphthenic oil residues formed a base for a highly efficient rot-proofing material. A process was developed for the greater recovery of vanadium from deposits in furnaces burning Venezuelan oils, some 323 tons of metal being obtained.

An increase in throughput to 280,000 brl daily on a plant designed to run at 230,000 brl was obtained by careful study of each operating unit, and the large increase in throughput generally, necessitated fastest possible tanker turn-around.

The San Lorenzo Refinery on Lake Maracaibo, Venezuela, doubled its daily intake of 19,000 brl. The Arend refinery on Aruba, designed for throughput of 5000 brl/day, was closed down in 1942 and reopened in March 1945, operating on an increasing output.

The United British Oilfields of Trinidad refinery increased its runs from 18,500 to 25,000 brl daily, and modifications made to produce asphalt and naphthenic oil residue. The Royal Dutch-Shell are building a complete refinery with a daily capacity in excess of 40,000 brl near Punta Cardon, Venezuela.

G. A. C.

**260. Products of Industry's Largest Manufacturing Unit have most Widespread Distribution.** C. O. Willson. *Oil Gas J.*, 13.10.45, **44** (23), 86.—A description of the Anglo-Iranian Oil Co's refinery at Abadan, Iran, which has a daily throughput of 360,000 brl and ranks as the world's largest not only in regard to throughput, but also in accumulated output, crude runs to stills having passed the one-billionth brl mark in July 1943. Its products, which are distributed over a large part of Europe and the remainder of the Eastern hemisphere, conform to the varying specifications of many countries. In addition, products serving a specific purpose and limited in demand to one area are manufactured.

The crude oil is drawn from the following fields: Masjid-I-Sulaiman, Haft-Kel, White Oil Springs, Gach Saran, and Agha Jari, and normally has a specific gravity of 0·846 with 3½% to 75° C, 8½% to 100° C, 21% to 150° C, 32% to 200° C with a total distillate (sp. gr. 0·773) of approximately 54% up to about 300° C.

A full description and a flow-sheet of all the refinery operations are given. These include crude-oil distillation, cracking and reforming, superfractionation, alkylation and isomerization, polymerization, $SO_2$ extraction, and preparation of special products. Regarding chemical treatments the methods used are mainly peculiar to the company's operations. Extensive use is made of the Holley–Mott type of washer, in which advantage is taken of the difference in gravities of oil, chemical, and oil/chemical emulsions. This type is used for acid-washing for sulphur removal, and hypochlorite sweetening. Conventional methods are used for plumbite and caustic-soda treatments.

Hydrochloric acid is manufactured for use on the refinery as well as lime, and

sulphuric acid using vanadium pentoxide catalyst can be produced at 264 tons per day. 63 boilers have a capacity of 4,750,000 lb/hr. and the power plant consists of 10 units with a total capacity of 91,500 k.w.h. T. M. B. M.

**261. Design of Class 1 Pressure Vessels.** E. J. Heeley. *Refiner*, Nov. 1945, **24** (11), 467–476. *Paper Presented before the Inst. Mech. Eng.*—The fusion-welded mild-steel pressure vessels generally known in Great Britain as "Class 1" welded pressure vessels are those of a sufficiently high standard of manufacture to comply with the requirements of certain recognized specifications, such as those referenced in the paper. Such vessels are constructed of good-quality mild-steel plate joined together by a metallic arc fusion-welding process. A radiographical examination is made of the full length of all the main seams, which are machined or dressed so as to be level with the surfaces of the plate on either side of the joint, and specified mechanical tests are carried out to ensure that the quality of the welded joint is of the required standard. The vessels receive a stress-relieving heat treatment on completion of the welding operations. The magnitude of the stress in the material is a dominant factor in the design of a pressure vessel, but difficulties arise in connection with the design of Class 1 fusion-welded pressure vessels on account of the different viewpoints of various authorities on the stress to be applied to the welded joint. The extent of these differences is shown in the paper by a comparison of vessels designed in accordance with the specification requirements of four leading authorities (two British and two American). An analysis is made of the factors involved in the formula employed by these authorities for determining the wall thickness, and it is shown that the formulæ have been based on the riveted form of construction despite the very different conditions of stress at Class 1 welded joints. The characteristic physical properties of such joints are discussed in conjunction with the results of recent investigations on their behaviour under fluctuating stress conditions. A recommendation is made for a much-needed simplification in design formulæ to take into consideration the actual characteristics of the welded form of joint. Illustrations are given of typical welding groove preparations for the attachment of flanges, branches, etc., designed to provide adequate accessibility for manipulation of the welding rods. A. H. N.

**262. Heat-Exchanger Design for Modern Refinery Processing.** S. Kopp. *Petrol. Engr.*, June 1945, **16** (9), 108.—The accepted codes for heat-exchanger equipment and standard of the Tubular Exchanger Manufacturers' Association (T.E.M.A.) are briefly reviewed. Heat-exchanger systems, types, their designed duties, components, measurements, tolerances, dimensions and thicknesses of tubes, corrosion allowances, construction and maintenance are outlined or discussed, and illustrated under the following sections: shell and multi-tube; floating head; fixed-tube sheet; u bend; double pipe and open section designs. Sketches with measurements are shown of a kettle-type reboiler; test-ring assembly; miscellaneous attachments of clamp-type exchangers; and tube-hole grooving in a tube sheet. Floating-head types are shown by nine sketches, and illustrations are given of, and the following are discussed: Air-cooler unit; Contactor cooler unit (Stratco); Tubeflow cooler. Other sections discussed relate to low-temperature and high-temperature service exchangers and extended surface exchangers, corrosion resistance, and the use of bi-metalllic linings or tubes. The method of installing bi-metallic tubes is given in a dimensioned sketch. W. H. C.

**263. Properties and Applications of Saran Pipe.** D. R. Williams. *Chem. Met. Eng.*, 1945, **52**, 113.—Saran resin is a thermoplastic vinylidene chloride-vinyl chloride copolymer combined with suitable plasticizers and pigments. It has been used for the construction of piping ranging in diameter from ½ to 4 ins. Saran pipe has proved very satisfactory in the handling of corrosive substances—*e.g.*, bromine vapour, warm 8%HCl, water containing $SO_2$, and phenol, etc. Its high electrical resistance enables it to be used for water lines between Hg arc rectifiers and in natural gas lines where electrolytic corrosion may ensue. Its main defects are its low thermal conductivity and low softening point (240–280° F), but this property enables repairs or joins to be effected very readily. Full details concerning the resistance of the material towards chemicals, its physical properties, and the strength, etc., of Saran pipe are given in the paper. L. B.

**264. Heat Transfer Coefficients for Pipe and Wire.** I. J. Hooks and F. Kerzer, Jr. *Chem. Met. Eng.*, 1945, **52**, 117.—Nomographs for the determination of forced convection heat-transfer coefficients for pipe and wire, and a chart for the determination of the coefficient of heat transfer by radiation, are given. L. B.

**265. Sampling Regenerator Outlet Flue Gas to Determine Change in Oxygen Content.** R. A. Rowe. *Petrol. Engr*, May 1945, **16** (8), 187.—The precautions necessary in sampling flue gases from a catalyst regenerator are discussed; they form an important part of this paper. It is necessary to prevent any entrained catalyst from entering any part of the sample withdrawal line and at the same time allow free and continuous flow of the gas to be sampled. The gas flow must be at a rate sufficient to eliminate any cooling problem and also allow the rapid registration of change in oxygen content of the gas. The arrangements for this purpose are described and shown in a diagram. The sampling tube, 24 × ¼ in, must be of 18–8 stainless steel, has at the regenerator end a ball stone filter (aluminium oxide aerator stone), which, after cementing on, is ground to a cylindrical shape 5/8-in diameter. This tube is inserted in a 1-in connector to the regenerator outlet line, so that the end of the stone filter cylinder is ½ to ¾ in from the flowing stream in the regenerator outlet.

The manner of fitting the sampling tube by a ferrule to the 1-in connecting tube which is constructed with a 1-in gate valve, two tees, and three valves; the functions of the latter, and the method of inserting the sampling tube and establishing its correct position before connecting it to the electrical oxygen detector, are described. The train of filtering, drying, and constant-pressure bottles is described. One of the two $CaCl_2$ drying bottles contains a ball-stone filter (not ground to a cylinder), the first and the last constant pressure bottles are open to the atmosphere and hold water to give 4½ and 3-in pressure, respectively.

The equipment for checking the electrical oxygen detector is shown in a sketch and is described. Samples are taken in football bladders fitted with a tube and clip, the equipment shows the needle valve and rubber connections, a filter and dryer consisting of a 4-oz bottle 1/3rd filled with $CaCl_2$, with ¼-in copper inlet and outlet tubes, the latter having a ball stone filter ground to a 5/8-in cylinder.

The procedure for taking a sample of the flue gas in the rubber bladder and thence to the Orsat burette is described. Periodic checks of the detector instrument are made. A calibration chart is shown. W. H. C.

## Cracking.

**266. U.O.P. MS-Type Catalytic Cracking Unit.** N. K. Anderson and M. J. Sterba. *Petrol. Times*, 22.12.45, 1080.—The U.O.P. MS-Type Catalytic Cracking Unit is specially designed to meet the needs of the smaller refiner. It retains all the advantages of the original fluid-type operation, but installation and running costs are greatly reduced by the fact that: (1) the regenerator and reactor are combined in a single vessel; (2) the large regenerator riser has been eliminated and the regenerator standpipe shortened; (3) all equipment for secondary catalyst recovery has been eliminated; (4) use of additional distribution grids has improved efficiency of reaction and regenera- pipe shortened; (3) all equipment for secondary catalyst recovery has been eliminated; (4) use of additional distribution grids has improved efficiency of reaction and regeneration; (5) air for the combustion passes through the regenerator countercurrent to the flow of the catalyst. A flow diagram, and tables giving yields and costs for operation at three different throughputs and with three different types of catalyst, are incorporated in the paper. L. B.

**267. Combustion-Gas Turbine in Houdry Process.** J. E. Evans and R. C. Lassiat. *Refiner*, Nov. 1945, **24** (11), R 461–466.—The thermodynamics and operational characteristics of combustion-gas turbines are discussed and analyzed. Reviewing briefly the operating data and observations reported, it is evident that variations in turbo-compressor air-delivery performance due to seasonal factors has proved to be of minor importance in the Houdry application—particularly in view of the savings in power resulting from use of the gas turbine. In consequence of process requirements, the machines have been subject to a certain amount of cyclic variation, in spite of which, operating factors of 98% have been averaged over many years of service.

Considering this on-stream time efficiency, maintenance costs which amount to about 3% of capital investment per year have been quite satisfactory. In the future other process industries may well wish to avail themselves of the unique properties of the turbo-compressor, particularly as the self-powered air compressor. The discussion of turbo-pressure-volume characteristics and seasonal variations should serve as a useful guide in synthesizing the performance charts needed in process exploratory work.
A. H. N.

**268. High-Capacity Operations on Fluid Cracking Units.** E. V. Murphree, E. J. Gohr, H. Z. Martin, H. J. Ogorzaly, and C. W. Tyson. *Refiner*, Nov. 1945, **24** (11), 423–426. *Paper Presented before A.P.I.*—Fluid catalyst cracking was developed originally by Standard Oil Development Co. as a means of increasing the yield and quality of motor gasoline and other saleable products which could be obtained from crude oil. However, with the advent of World War II the possibilities of this process for production of such important war materials as aviation gasoline, butylenes for rubber manufacture and toluene for explosives, became fully appreciated. As a result many plants were quickly designed and constructed throughout the United States in order to provide the Army and Navy with the desired large quantities of these materials. As the war progressed the demands for these strategic materials increased considerably. Because of their flexibility many of the fluid-cracking plants were able to make extensive increases in capacities above the design values, and thus aided significantly in preventing a shortage of petroleum products. There are in operation at the present time 34 fluid-catalyst cracking units, and about nine additional plants are undergoing design or construction. Of this total of 43 plants, all but six are located in the United States. The nominal design cracking capacity for these plants is about 540,000 brl/day, in many cases based on the more severe operations for production of aviation gasoline components. However, it is estimated that under the less severe operating conditions which are best suited for maximum yield of motor gasoline the total feed capacity of these plants would be approximately 720,000 brl. As was stated above, these values are estimated on the basis of the design carbon-burning capacities of these plants. The downflow plants of the affiliates of the Standard Oil Co. (New Jersey) originally were designed for a feed rate of 15,500 brl/day when operating under conditions advantageous for the production of the wartime products. At the time the units were designed it was estimated that under conditions for motor-gasoline production the feed capacity would be about 20,000 brl.

The paper describes the means by which difficulties were overcome. A. H. N.

**269. Liquid-Charge Technique in TCC Processing.** T. P. Simpson, S. C. Eastwood, and H. G. Shimp. *Refiner*, Nov. 1945, **24** (11), 436–442. *Paper Presented before A.P.I.*—An adaptation of the TCC process, called liquid-charge technique, is described for catalytic cracking of the heaviest types of petroleum charge stocks. High yields of high-quality motor gasoline and distillate fuel oils are produced. The reactor used is the concurrent solid-bed downflow type with provision for introducing the feed at the top and removing the cracked products from the bottom. The charge may comprise total liquid or mixed liquid-vapour feed. Catalyst-to-oil ratios need not be high to achieve this desired conversion with reasonable oil and catalyst inlet temperatures. Studies on a number of stocks show that catalyst-to-oil ratios of 1·8–4·0, by volume, are adequate. Overcracking may occur at higher catalyst-to-oil ratios, resulting in a rapid increase in coke and gas production with a loss in gasoline yield and liquid recovery. Charge stocks should be below about 4% by weight Conradson carbon residue to maintain coke tendency at reasonable levels. Heavy asphaltic stocks give excessive coke, and should be deasphalted before they are charged to the cracking unit. Deasphalting greatly reduces the coke tendency, and results in improved yields of motor gasoline from a given capacity unit. Data are given to demonstrate that the liquid charge technique catalytic reaction proceeds extremely rapidly, with about 70% of the cracking occurring at a point representing only 12% of the total path through the reaction zone.
A. H. N.

**270. Economic Survey of Thermofor Installations in Socony-Vacuum Lubricating Oil Refineries.** H. C. Meyers and R. M. Owen. *Oil Gas J.*, 4.8.45, **44** (13), 93.—The operating data, capital invested, and royalties paid are given for Thermofor kiln

regenerators of 30, 50, and 110 tons/day rated capacity, operated at five Socony-Vacuum refineries. Costs are shown for the regeneration of various refining earths: (A) fullers earth, Thermofor regenerated, in comparison with regeneration in multiple-hearth rotary kilns, after operation on (1) Pennsylvanian cylinder stocks, S.A.E.-20 motor oil, and petrolatums in 40% naphtha; (2) Mid-Continent bright stocks, neutrals, petrolatums, waxes, and cerasins both straight and in naphtha solutions; and (B) Bauxite Thermofor regeneration compared with bone char regeneration in Deely-Kent retorts, after Mid-Continent wax filtrations. Basic labour, repairs, maintenance and utilities, adsorbent losses and discard costs, and the savings due to the Thermofor method are shown. The installation of Thermofor kilns has shown substantial lowering of operating expenses, and the reactivated earths retain their efficiency after repeated regenerations far better than the methods formerly used. The extent of savings depends on the size of plant, effect of previous absorbent employed, and the method of regeneration. The economies resulting from the Thermofor process indicate an average amortization period of from 8–9 months. The quantities of earth replacement necessary and the number of regenerations possible are shown. W. H. C.

## Alkylation.

**271. Corrosion in Hydrofluoric Acid Alkylation.** M. E. Holmber, and F. A. Prange. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1030–1033.—The number of desirable materials of construction for anhydrous hydrofluoric acid service is comparatively small. Carbon steel is the basic material, and is adequate for pressure vessels up to a temperature of approximately 150° F; Monel metal or Monel-clad steel is the desirable material for higher temperatures. Cupronickel might be particularly suitable in heat-exchanger tubes. Monel metal is the desired material for valve trim in severe service. Materials to be avoided can be divided into three classes. The first class is made up of straight chrome stainless steels and copper alloys (except cupronickel), which are velocity sensitive in anhydrous hydrofluoric acid, and in high concentrations of the acid. The second class, materials which may be attacked by intergranular corrosion, includes Hastalloy A and B, cast iron, and high-zinc, uninhibited brasses. The third class, materials used for piping and fittings that are brittle or notch-sensitive, includes free-machining steel, high-phosphorus steel, and others of similar properties.

A. W.

## Metering and Control.

**272. Unit Coefficients for Orifice Meters.** T. K. M. Smith. *Refiner*, Nov. 1945, **24** (11), 477–478. **Maintenance of Orifice Meter Plates and Tubes.** W. Bostrom. *Refiner*, Nov. 1945, **24** (11), 478–479. **Temperature Determinations in Orifice Meter Runs.** M. McIlvaine. *Refiner*, Nov. 1945, **24** (11), 479–480. **The Orifice-Meter Fitting.** G. B. Reece. *Refiner*, Nov. 1945, **24** (11), 480.—These are parts of the Southern California Meter Assoc. Meter Course. A. H. N.

## Safety Precautions.

**273. Safety in Arc Welding.** R. F. Wyer. *Refiner*, Nov. 1945, **24** (11), 481–484.—A discussion of the hazards and the safety precaution to be taken in arc welding is presented. A. H. N.

# PRODUCTS.

## Chemistry and Physics.

**274. A New Hydrocarbon.** M. Nierenstein and C. W. Webster. *J. Amer. chem. Soc.*, 1945, **67**, 691.—A new tri-nuclear hydrocarbon, "Ellagene," $C_{28}H_{14}$, has been prepared by zinc-dust distillation of the pyridine insoluble fraction of ellagic acid prepared according to Perkin and Nierenstein. Ellagene has m.p. 197° C., picrate 117° C., benzylidene deriv. 107° C. J. H. P.

**275. Solubility of Water in Alcohol-Hydrocarbon Mixtures.** C. B. Kretschmer and R. Wiebe. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1130–1132.—Critical solution

temperatures with water have been studied for a number of blends of ethyl alcohol with a single hydrocarbon, or representative paraffins, olefines, and naphthenes being chosen. The solubility of water in several blends containing ethyl alcohol in a mixture of two hydrocarbons have also been determined, together with the effect of small proportions of stabilizers on the C.S.T. of an *iso*octane, alcohol and water blend. It is shown that the more volatile gasolines will have higher water tolerances, and that higher alcohols seem the most suitable agents for increasing the water tolerance of a gasoline-alcohol blend. A. W.

**276. Cyclic Dimerization of *iso*Butylene.** J. B. McKinley, D. R. Stevens and W. E. Baldwin. *J. Amer. chem. Soc.*, 1945, **67** 1455–1459.—A cyclic dimer identified as 1 : 1 : 3-trimethyl*cyclo*pentane results as the main product of the polymerization of *iso*butylene at high temperatures and pressures. A conventional synthesis of the trimethyl*cyclo*pentane is described in the course of which a new substance, optically inactive 1-chloro-1 : 3-dimethyl*cyclo*pentane was isolated. J. H. P.

**277. Volume of Mixing and the Thermodynamic Functions of Binary Mixtures. II. Benzene*cyclo*hexane.** S. E. Wood and A. E. Austin. *J. Amer. chem. Soc.*, 1945, **67**, 480–483.—The volume change on mixing benzene and *cyclo*hexane at constant pressure over the composition range from 15° to 75° has been determined and the changes of the thermodynamic functions on mixing at constant volume calculated. The volume of mixing is positive, and generally increases with temperature, and the excess entropy over that of an ideal solution on mixing at constant volume is also positive over this temperature range. J. H. P.

**278. Reaction of Aromatics in Presence of Dehydrogenation Catalysts. I. Action of Chromia—Alumina on Benzene, Toluene, Butylbenzenes, and Bibenzyl.** W. J. Mattox and A. V. Grosse. *J. Amer. chem. Soc.*, 1945, **67**, 84–86.—The conversion of various types of hydrocarbons into aromatics by dehydrogenation or aromatization catalysts raises the question of what action such catalysts exert on the aromatics formed. The authors summarize typical data obtained in such processes in the case of benzene and substituted benzenes having up to 8 carbon atoms in 2 or more alkyl groups. J. H. P.

**279. Non-benzenoid Aromatic Hydrocarbons.** W. Baker. The Tilden Lecture, *J. Chem. Soc.*, 1945, 258–267.—The literature of the non-benzenoid aromatic hydrocarbons is critically reviewed. The monocyclic *cyclo*butadiene, *cyclo*octatetraene, and the fulvenes; the dicyclic pentalene and azulene systems; and the tricyclic diphenylenes are discussed in detail and compounds with four-membered rings fused to a benzene nucleus are also noted.

The evidence for the non-existence of *cyclo*butadiene is not sufficient, and the possibility of its preparation from 1-bromo-$\Delta^3$-*cyclo*butene by halogen elimination and subsequent exhaustive methylation must be borne in mind.

The preparation by Willstätter in 1911 of a hydrocarbon believed to be *cyclo*octatetraene from $\gamma$-pelletierine has received new and widespread attention following the observation that its properties strikingly resemble those of styrene. The only known cases of genuine *cyclo*octatetraenes are the recently prepared benzo-derivatives tetraphenylene (1 : 2 : 3 : 4 : 5 : 6 : 7 : 8-tetrabenz-$\Delta^{1:3:5:7}$-*cyclo*octatetraene and 1 : 2 : 3 : 4 : 5 : 6-tribenz-$\Delta^{1:3:5:7}$-*cyclo*octatetraene. The absorption spectra of these compounds gives evidence of the possible existence of *cyclo*octatetraene itself.

The simplest bicyclic aromatic system apart from *cyclo*butadiene which might exist is " pentalene " having two fused fulvene rings and resembling naphthalene. Recent work shows that naphthalene is a unique dicyclic hydrocarbon, and that the *bicyclo*octatetraene has no aromatic characteristics. This is in part accounted for by the fact that in pentalene there are only four electrons not necessarily involved in covalency formation in each ring, whereas in typical benzenoid compounds there are six.

The azulenes are comparatively stable, and there is no evidence of their conversion into the isomeric naphthalenes. It is now known that the azulenes have lower bonding and resonance energies than naphthalene.

" Diphenylene " or *cyclo*butadibenzene is isomeric with acenaphthylene, and has long been considered as a possibly aromatic type. Five arrangements of the bonds are possible, four dibenzenoid and one doubly *ortho*quinonoid. Recently it has been

established that diphenylene may be regarded as a unique type of molecule, in which the butadiene structure is stabilized by fusion with the two benzene rings, and in which the expected instability due to strain is countered by increased stability due to resonance. It is probably the only type of molecule having an aromatic nucleus fused to a four-membered ring. J. H. P.

**280. Catalytic Cracking of Pure Naphthene Hydrocarbons.** B. S. Greensfelder and H. H. Voge. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1038–1043.—Continuing cracking studies of pure hydrocarbons over a silica–zirconia–alumina catalyst under certain conditions similar to those in the commercial cracking of petroleum fractions, eleven naphthenes containing 6–18 carbon atoms were studied. It was found that naphthenes are quite susceptible to the action of the catalyst, the rate of cracking being mostly dependent on molecular weight, both ring and any side-chains all contributing to the total cracking. Hydrocarbon fragments of three or more carbon atoms are preferentially produced, the products of cracking being more saturated than those of paraffins or aliphatic olefines. Isomerization of $C_6$ to $C_5$ rings occurs and there is considerable dehydrogenation of $C_9$ or higher *cyclo*hexane types to aromatics. Compared to the thermal cracking of naphthenes the catalytic treatment gives a considerably faster reaction, more saturated products, higher liquid–gas ratio, less hydrogen formation from $C_{10}$ and higher naphthenes, and smaller amounts of condensation products. A. W.

**281. Butadiene Purification by Solvent Extraction.** A. S. Smith and T. B. Braun. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1047–1052.—An apparatus and a method used to investigate solubility and distribution in $C_4$ olefin-solvent systems are described. Mixtures of components were used to obtain solvents of desirable characteristics, and data are presented for three types, miscible, immiscible, and a miscible solvent mixture containing complex-forming salts. The small differences in physical properties between butadiene and the $C_4$ mono-olefins preclude the possibility of an ideal solvent. The choice of solvent must be made on an economic basis. There is a discussion on the general applications of extraction processes and on quaternary systems. A. W.

**282. Studies in the Terpene Series. II. Hydrogen Disproportionation of Limonene.** V. N. Ipatieff, H. Pines, and R. C. Olberg. *J. Amer. chem. Soc.*, 1945, **67**, 694.—Cyclic *mono*olefines and *p*-cymene resulted on distillation of *d*-limonene in the presence of small amounts of organic bromides; owing to hydrogen disproportionation. The effects of other catalysts on the degree of hydrogen transfer are discussed. J. H. P.

**283. Catalytic Dehydration of 1-Hexanol and 1-Octanol.** V. I. Komarewsky, S. C. Uhlick and M. J. Murray. *J. Amer. chem. Soc.*, 1945, **67**, 557–558.—Vapour-phase dehydration of 1-hexanol and 1-octanol over alumina, gave 1-hexene and 1-octene, respectively. The products were identified by their physical constants and Raman spectra and by hydrogenation to corresponding paraffins. J. H. P.

**284. Effects of Temperature on the Polymerization of Styrene.** S. G. Cohen. *J. Amer. chem. Soc.*, 1945, **67**, 17–20.—The polymerization of styrene catalyzed by benzoyl peroxide was studied. The rates of polymerization and the molecular weights of the products increased with rise in temperature of reaction, the rates rising more rapidly than the molecular weights. It was concluded that a reaction of lower activation energy than that of chain growth was the dominant factor, chain transfer reactions being of minor importance only.

Important theoretical and practical implications of these results were noted. J. H. P.

**285. Preparation of 1 : 3- and 1 : 4-Pentadienes from Furfural.** L. E. Schniepp and H. H. Geller. *J. Amer. chem. Soc.*, 1945, **67**, 54–56.—By the pyrolysis of the diacetates of 1 : 2- and 1 : 5-pentanediols obtained as hydrogenation products from furfural, pure 1 : 3- and 1 : 4-pentadienes may be prepared. The pyrolysis proceeds via the intermediate pentene-olacetates. J. H. P.

**286. Preparation and Physical Constants of Acetylenic Compounds.** A. L. Henne and K. W. Greenlee. *J. Amer. chem. Soc.*, 1945, **67**, 484–485.—A series of acetylenic derivatives was prepared from sodium acetylides by condensation reactions in liquid

ammonia. The experimental conditions described gave high yields, and enabled accurate determination of the physical constants of the products to be made. J. H. P.

**287. N.G.A.A. Standard Table of Physical Constants for Paraffin Hydrocarbons.** Anon. *Oil Gas J.*, 13.10.45, **44** (23), 115.—A table of physical constants of the *n*-paraffins up to *n*-decane is given. The constants include formula, molecular weight, melting point, boiling point, density of liquid and vapour, critical conditions, heat of combustion, explosive limits, heat of vaporization, specific heat, vapour pressure, aniline point, and refractive index.

A reference bibliography and other general constants are included. T. M. B. M.

**288. Vapour Pressures and Boiling Points of some Paraffin, Alkyl*cyclo*pentane, Alkyl*cyclo*hexane, and Alkylbenzene Hydrocarbons.** C. B. Willingham, W. J. Taylor, J. M. Pignocco, and F. D. Rossini. *Bur. Stand. J. Res., Wash.*, Sept. 1945, **35**, 219.—Measurements of vapour pressures and boiling points over the range 47–780 mm of mercury and above about 12° C have been made on 52 hydrocarbons prepared and purified in connection with the work of the A.P.I. Research Project 6 at the National Bureau of Standards.

The apparatus consisted of an electrically heated boiler (a full description and drawing of which is given) having a vapour space with a vertical re-entrant tube containing a platinum thermometer having a resistance of 25 ohms, and a condenser.

Measurements of the temperature of the liquid–vapour equilibrium were made at 20 automatically maintained fixed pressures. The value of the fixed pressures were determined by calibration of the apparatus with water by using the vapour pressure–temperature tables prepared at the N.B.S.

The purity of the compounds investigated is listed, and from the method of preparation and purification it is concluded that, (*a*) the remaining impurities were substantially isomeric and close boiling, and (*b*) their amount was such as to have no significant effect upon the measurements.

The experimental data on the hydrocarbons examined were correlated, the method of least squares being used, with the three-constant Antoine equation for vapour pressures; $\log P = A - B/(C + t)$ or $t = B/(A - \log P) - C$. Experimental data, together with the values of the three constants of the Antoine equation, applicable over the range of measurement, are tabulated. The hydrocarbons examined were 30 paraffins (two pentanes, five hexanes, three heptanes, 17 octanes, and *n*-nonane, decane and dodecane), *cyclo*pentane and three alkyl*cyclo*pentanes (methyl-*n*-propyl-, and *iso*propyl-), *cyclo*hexane and nine alkyl*cyclo*hexanes (methyl-, ethyl-, *cis-* and *trans*-1 : 2-dimethyl-, *cis-* and *trans*-1 : 3-dimethyl-, *cis-* and *trans*-1 : 4-dimethyl- and *n*-propyl-) together with benzene, toluene, and ethylbenzene, the three xylenes, and *n*-propyl and *iso*propyl-benzenes. T. M. B. M.

**289. Mechanism of Hydrogen Fluoride Catalyzed Alkylation of Toluene by *t*-Butyl Chloride.** W. H. Pearlson and J. H. Simons. *J. Amer. chem. Soc.*, 1945, **67**, 352–362.—The effects of water, methanol, diethyl ether, and hexamethylacetone as promoters in the reaction between toluene and *t*-butylchloride, catalyzed by hydrogen fluoride, has been studied in detail. It was found that the reaction rate increases with increased concentration of the promoter, but that the four promoters gave essentially the same effect at the same molar concentration. Experiment confirmed that the amphoteric medium effect contributes to the mechanism of the reaction. In an exhaustive discussion of the theoretical considerations involved the authors demonstrated that a one step, condensed phase, catalyzed, and promoted reaction is the essential factor in the mechanism of the reaction, and that the postulates of ions or free radicals as intermediates are inadmissible.

Details are given of the special apparatus employed and of the method for the intensive drying of toluene using sodium triphenylmethyl; metallic sodium or phosphorus pentoxide being found to be inadequate for this purpose. J. H. P.

**290. Acidic Constituents of Degras. A New Method of Structure Elucidation.** A. W. Weitkamp. *J. Amer. chem. Soc.*, 1945, **67**, 447–454.—The isolation and identification of 32 acids originally present as sterol esters in a sample of commercial degras is described. They comprise: nine normal fatty acids, $C_{10}$ to $C_{26}$; two optically active 2-hydroxy-acids, $C_{14}$ and $C_{16}$; ten *iso*-acids, $C_{10}$ to $C_{28}$; and eleven dextro-rotatory anteiso acids $C_9$ to $C_{27}$ and $C_{31}$.

The method of structure elucidation which is applicable to acids or amides with simple branched chains is based on the transition points in the solidification point curves of binary mixtures of the branched acid or amide with normal fatty acids or amides. J. H. P.

**291. A Kinetic Study of the Dehydrochlorination of Substituted 2 : 2-Diphenylchloroethanes Related to D.D.T.** S. J. Cristol. *J. Amer. chem. Soc.*, 1945, **67**, 1494–1498.—The dehydrochlorination reactions with sodium hydroxide of 11 2 : 2-diarylchloroethanes related to D.D.T. were found to be of the second-order $E_2$ type. The rate constant for the *o* : *p*′-D.D.T. isomer, the principal impurity in technical D.D.T., is 1/67th that of the *p* : *p*′-D.D.T. isomer, which is the principal insecticidal agent. J. H. P.

**292. Chemical Composition of Technical D.D.T.** H. L. Haller and co-workers. *J. Amer. chem. Soc.*, 1945, **67**, 1591–1602.—Theoretically 45 isomeric dichlorodiphenyltrichloroethanes exist, but the term "D.D.T." is restricted to the condensation product of chloral and chlorobenzene in the presence of sulphuric acid. There are three standard qualities of D.D.T.: technical D.D.T., purified or aerosol D.D.T. and pure D.D.T. which is specially prepared as a pharmacological standard and is of m.p. 108·5–109·0° (corr.).

Fractional crystallization, chromatographic, and cryoscopic methods showed technical D.D.T. to be a complex mixture containing over 70% of 1-trichloro-2 : 2-bis-(*p*-chlorophenyl)-ethane. The major impurity is the *o* : *p*′-D.D.T. isomer but 12 other organic impurities were isolated and identified.

In the course of the work all six isomeric dichlorobenzophenones with one chlorine atom on each ring were prepared. The *o* : *p*′- and *m* : *p*′-isomers of *p* : *p*′-D.D.T. are also described. J. H. P.

**293. Crystal Behaviour of Paraffin Wax.** S. W. Ferris and H. C. Cowles. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1054–1062.—It is believed that the many conflicting explanations given for the crystal behaviour of paraffin wax are often contradictory because of the erroneous assumption that petroleum waxes are chemically homogeneous. From photomicrographic studies, convincing evidence is presented in support of the following theory:

"Petroleum waxes consist of mixtures of hydrocarbons belonging to various homologous series. The members of each series crystallize similarly, as either plates, malcrystals or needles. If but one type (plate, mal or needle) is present, the crystal form remains the same regardless of such factors as amount or kind of solvent. If the types are mixed, and if the solubility relations are such that more than one type can crystallize simultaneously, either the needle or mal can impress its form on the plate. If, on the other hand, sufficient solvent is present to maintain needles and mals in solution until plates are well established, mals and needles can then deposit upon, and thus take the form of plates." A. W.

**294. Oxidation of Lubricating Oils.** C. H. Denison and P. C. Condit. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1102–1108.—A previous paper has demonstrated that the oxidation stability of normally refined petroleum lubricating oils is the result of small quantities of natural sulphur compounds. Work has been continued by studying the reactions by which organic sulphur compounds stabilize these lubricants against oxidation. Monothioethers, which contain at least one aliphatic or naphthenic group attached to the sulphur atom, appear to be the most effective sulphur-type antioxidants tested, their effectiveness varying, apparently, with the rapidity with which they reduce peroxides. The thioethers studied were relatively resistant to autoxidation, but susceptible to oxidation by peroxides. Thioethers function as inhibitors as the result of reducing peroxides, thus breaking the oxidation chain. In this reaction thioethers are converted to sulphoxides and probably to sulphones. By autoxidation these latter two types of compounds are in part converted to sulphonic acids. A. W.

**295. Adsorption of Water Vapour on Carbon Black.** P. H. Emmett and R. Anderson. *J. Amer. chem. Soc.*, 1945, **67**, 1492–1494.—After high-temperature degassing typical carbon blacks gave water isotherms resembling those found for steam activated charcoal. It was established that the samples did not develop porosity or increase in surface area during degassing. J. H. P.

**296. The Present Era in Combustion.** D. T. A. Townend. *Chem. and Ind.*, 1945, 346–351.—A survey of recent researches into combustion phenomena.
C. F. M.

## Analysis and Testing.

**297. An Improved Gas Absorber for Determination of Butadiene.** P. J. Elsing and T. L. Stein. *Industr. Engng. Chem. Anal.*, Nov. 1945, **17** (11), 722–723.—An absorber of the contact type is described, which can be used to determine butadiene in gaseous mixtures that are suitable for analysis by the Tropsch-Mattox or similar absorber. It is applicable to other methods of gas analysis where a minimum amount of reagent is to be used with efficient absorption. A. W.

**298. Copper Alkyl Phthalates for the Estimation of Mercaptans.** E. Turk and E. E. Reid. *Industr. Engng. Chem. Anal.*, Nov. 1945, **17** (11), 713–714.—The preparation and use of copper alkyl phthalates for the titration of mercaptans are described. Two important advantages of this method over the iodine titration are: (*a*) the reaction takes place in homogeneous solution, and (*b*) there is no interference by unsaturates. Of the two phthalates investigated, copper octyl phthalate is very soluble in hydrocarbons and may be more convenient for the estimation of mercaptans in petroleum products, than copper butyl phthalate. Primary, secondary and tertiary mercaptans can all be satisfactorily estimated, the results being in substantial agreement with those using the iodine method. No interference from compounds such as hydrogen, cyanide, organic thiocyanates, organic sulphides and terpenes, was observed. The method is, however, not applicable when hydrogen sulphide is present in the mercaptan solution, and two mercaptans, thioglycollic acid and dithioethylene glycol are not amenable to titration. A. W.

**299. Colourimetric Determination of D.D.T.** M. S. Schechter, S. B. Soloway, R. A. Hayes, and H. L. Haller. *Industr. Engng. Chem. Anal.*, Nov. 1945, **17** (11), 704–709.—A colorimetric method has been developed for the estimation of D.D.T. down to about 10 micrograms. The method involves intensive nitration and the production of colours by the nitrated products in benzene with methanolic sodium methylate. This colour reaction is being applied to the analysis of spray residues and water samples, and can also be used as a test for degradation products of D.D.T. and some related compounds.
A. W.

**300. Deterioration of Analytical Weights.** *Letter by* A. F. H. Ward. *Chem. and Ind.*, 1945, 393.—Attention is drawn to observations on the deterioration of precision weights made by Manley (*Phil. Mag.*, 1933, **16** (7), 489). It was shown that over a storage time of one year the change in mass of gold-plated brass weights was 24 times that of chromium-plated weights. Detailed recommendations were also made for improvements in weight boxes which reduced the rate of corrosion about 30-fold.
C. F. M.

**301. Note on an Improved Falling Sphere Viscometer for Use with Opaque Liquids.** C. A. McDowell and B. Y. Walker. *Chem. and Ind.*, 1945, 323.—Passage of the sphere is detected by means of coils wound on the viscometer-tube. These coils (placed at either end of the fall) are incorporated in oscillating circuits and the disturbance in frequency of oscillation caused by the sphere gives rise to a change in the note audible on headphones. It is claimed that the circuit given is more sensitive than those previously described. C. F. M.

**302. A New Method to Determine Paraffin Wax in Asphalt.** J. Muller and D. Wandycz. *Refiner*, Nov. 1945, **24** (11), 458–460. (Translated by E. J. Barth from *Asph. u. Teer* (*Strassenbautechnick*), **32** (36), 108–111).—By a series of differential solvent extraction and chilling, a pure paraffin wax is obtained from asphalt. This is used for analytical purposes. A. H. N.

## Engine Fuels.

**303. Effect of Organic Chlorine and Sulphur on Octane Number and Lead Susceptibility of Gasoline.** C. Holloway and W. S. Bonnell. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1089–1091.—Work has been carried out to ascertain whether organic chlorine in gasoline has a similar effect to organic sulphur, small proportions of which lower

the octane number and lead susceptibility. Synthetic samples containing from 0 to 1·0 wt % chlorine as organic chlorides were prepared and tested for motor-method octane number, lead susceptibility, corrosion and gum. The gum and corrosion tests were negative at chlorine concentrations of 0·1 wt % and lower; the effect of organic chlorides on lead susceptibility was so great as to indicate that, above 0·001 wt %, chlorine should not be tolerated in gasoline. This figure may, however, be modified slightly depending whether normal, secondary or tertiary chlorides are present, since the results obtained show that a primary chloride has a smaller effect on lead susceptibility than its tertiary isomer.

Work with another gasoline, and using 1-C aviation-method octane ratings has indicated about the same permissible concentration, both for organic chlorides and for a number of organic sulphur compounds. A. W.

## Gas Oil and Fuel Oil.

**304. Peacetime Fuel Oils from War Equipment.** A. E. Pew, Jr., J. B. Hill and J. R. Bates. *Refiner*, Nov. 1945, **24** (11), 450–452. *Paper presented before A.P.I.*—A brief study of domestic burners and their requirements is given, followed by a description of the principal properties required in fuels for burners and of the methods of producing such fuels. A. H. N.

## Lubricants.

**305. Oil for the Post-war Car.** H. L. Hemmingway. *Refiner*. Nov. 1945, **24** (11), 453–457.—The engine manufacturers indicate that in post-war engines the crankcase capacity will remain about the same, oil-change periods the same or longer, oil temperatures the same or higher, piston temperatures the same or higher, and more effective oil and air filters will be used. Babbitt bearings will predominate in passenger cars, with hard-alloys or new heavy-duty type bearings in heavy-duty engines. It would appear that a smaller percentage of engine bearings would be subject to oil corrosion than was the rule in prewar equipment. The manufacturers will recommend the same SAE grades as before the war, or lighter in some cases. " Regular " straight mineral oils or intermediate type (API " Premium " classification) oils will be recommended for passenger cars, while the manufacturers of heavy-duty engines prefer the full detergent " Heavy-Duty " or 2-104 B type. The general preference is for oils of 90 viscosity index or better, although some manufacturers prefer the 50 to 90 range, and some have no preference. They feel that the most needed improvement in oils should be along the lines of reducing engine deposits, increasing oil life, and reducing bearing corrosion.

To meet these requirements, the United States petroleum industry has a 35% increase in solvent refining capacity, as compared with 1939. Additive capacity is available to treat all of the expected postwar truck and bus demand as full heavy-duty (2-104 B) type, and at least 80% of the passenger-car demands as the intermediate or " premium " oil types. The war-sponsored investigations of low-temperature properties and the increase of 140% in U.S. solvent dewaxing capacity during the last seven years should result in improved low-temperature performance of lubricating oils. The manufacturing capacity for viscosity-index-improver types of additives has been increased and the stability of these products improved. Effective anti-foam agents have been developed. Both types of additives should find increased application postwar. New synthetic lubricants having unusual properties have been developed during the war period. While these materials probably will displace petroleum lubricating oils in special applications, the high cost of these materials at present precludes competition with petroleum oils for engine lubrication.

New developments in the field of fundamental research on lubricants should place the oil refiner in an improved position to meet the problems of lubricating postwar automotive equipment. A. H. N.

**306. Correlation of Chemical Constitution and Oxidation Susceptibility of Lubricating Oil Components.** S. F. Kapff, J. R. Bowman, and A. Lowy. *J. Inst. Petrol.*, Dec. 1945, **31** (264), 453–474.—This paper presents a study of the influence of chemical constitution on the susceptibility to oxidation of the several general types of components in petroleum lubricating oils. A fractionation of a Pennsylvania lubricating oil-stock has been effected by distillation and extraction. The physical properties of the fractions and

their chemical constitutions as calculated by Waterman's method are reported. Selected fractions were oxidized, and the extent of oxidation was measured by the acidity developed and by the increase of viscosity. Similar treatment was then applied to a different stock; fractions from the two stocks gave the same behaviour on oxidation. From the collected data, some generalizations have been made concerning the dependence of oxidation susceptibility on chemical constitution. A. H. N.

**307. Contact Inhibition or Lubrication.** C. Ridley. *Petrol. Times*, 22.12.45, 1076.—It is recognized by engineers that lubrication is the weakest link in an engine. The pure lubricant not only does not prevent scoring of surfaces when moving parts start up from rest, but is also incapable of withstanding adequately the conditions of high temperature and pressure arising from the greatly increased duties demanded of modern engines. The incorporation of suitable additives in the oil overcomes many, but not all, of the defects. Various methods for preventing metallic contact between moving surfaces have been recommended. One claim is for the "lubrication" of a 4 in shaft rotating at 20,000 r.p.m. by means of compressed air supplied at 30 p.s.i. Other methods involve: (1) the addition of 0·1-mm hard steel balls to the oil; (2) the flotation of the spindle in its bearing by oil supplied under pressure; (3) the suspension of the shaft in its bearing by means of magnets. L. B.

## Asphalt, Bitumen and Tar.

**308. Co-operative Research in the Road Emulsion Industry by the Technical Sub-Committee of the Road Emulsion and Cold Bituminous Roads Association.** E. R. Hatt and W. R. Peard. *J. Soc. chem. Ind.*, 1945, **64**, 243–253.—The paper describes the work which has been done to determine the conditions and emulsion compositions which lead to the formation of emulsion residues, or coagula which exhibit lack of binding power, and hence to indicate those compositions and conditions to be avoided in practice. Films of emulsion made with bitumens of different penetration and containing varying amounts of emulsifier and excess alkali are dried under precise conditions in a temperature- and humidity-controlled cabinet, and at intervals the films are weighed and examined both visually and by probing. During drying the emulsions pass through several distinct stages before the final adhesive film of binder is produced; one of these stages may correspond to a condition of poor mechanical strength. It was established that the hardness of the bitumen at the drying temperature was a considerable factor in the formation of non-ductile residues of weak binding power, and that the rate of drying and the type of emulsifier were of lesser importance. However, at low temperatures sodium soap emulsifiers may be unsuitable and excess free alkali is to be avoided. F. J. W.

**309. Physical Properties of Road Aggregates as Affecting Road Performance.** B. H. Knight. *J. Soc. chem. Ind.*, 1945, **64**, 254–259.—The physical properties of road aggregates and their significance in relation to road performance are discussed.

Particular attention is given to the following:—

Shape and size of aggregates; abrasion tests; absorption of water by aggregates; attrition tests; aggregate crushing tests; impact tests; soundness tests; rolling tests; degradation of aggregates during compaction and under traffic; adhesion of binders to aggregates. F. J. W.

**310. Chemistry and Constitution of Asphalts.** B. A. Murphy. *J. Inst. Petrol.*, Dec. 1945, **31** (26), 475–485.—The probable structures of different broadly-classified components of asphalt are discussed, and a general structural formula of complex substituted rings is proposed. A. H. N.

## Special Hydrocarbon Products.

**311. Corrosive Action of Benzole Absorption Oils.** C. M. Cawley and H. E. Newall. *J. Soc. chem. Ind.*, 1945, **64**, 285–290.—The corrosion which occurs in plant used for stripping benzolized wash oil has been found to be due to the presence in solution or in suspension of water-soluble salts which are associated to a large extent with asphaltic material possibly as an adsorbate.

Analyses of aqueous extracts of corrosive oils indicate the presence of ammonium thiocyanate and chloride. While the latter is the more powerful corrosion agent, the

former is present in greater concentration, and is considered to be the agent chiefly responsible for corrosion. These two salts are slightly soluble in creosote, but insoluble in gas oil. The presence of water enables suspensions of aqueous solutions to be formed, but such suspensions in gas oils are stable only on the rare occasions where soluble asphalt is present. Thus samples of used gas oil were found to be non-corrosive when examined in the laboratory.

At least some of the ammonium thiocyanate is probably formed by reaction between ammonia and carbon disulphide in solution in the wash oil.

It has been demonstrated that both iron sulphide and Prussian blue (which are often associated with corrosion of benzole absorption plants) are formed by the reaction of iron with ammonium thiocyanate in the presence of water and dissolved air. C. F. M.

**312. Residual Toxicity of D.D.T.** H. L. Sweetman. *Soap*, Dec. 1945, **21** (12), 141.—In view of the conflicting evidence as to the periods for which D.D.T. residues from sprays remain toxic, a series of tests has been carried out on firebrats, silverfish and cockroaches, in which the insects were left in contact with paper which had been sprinkled with D.D.T. dust and exposed to varying temperature and humidity conditions for different periods. There were definite indications that insects coming into contact with treated surfaces, rapidly reduced the effectiveness thus also reducing the residual effective period. Temperature conditions of 32–37° C. and high humidities definitely reduce its period of toxicity, but in colder or drier conditions this period may amount to 70 days. C. L. G.

**313. Effect of pH on Fungistatic Activity of Dinitro-o-Cresol.** P. W. Brian. *J. Soc. chem. Ind.*, 1945, **64**, 315–316.—It is shown that the fungistatic activity of dinitro-*o*-cresol solutions decreases with increase of pH and that it is closely related to the concentration of undissociated D.N.O.C. present. It is suggested that the increased insecticidal effectiveness of D.N.O.C.-petroleum oil washes at low pH can be accounted for by the increased concentration of undissociated D.N.O.C. rather than the increased concentration of D.N.O.C. in the oil phase. F. J. W.

**314. Action of Certain Insects of Fabrics Impregnated with D.D.T.** H. Hayhurst. *J. Soc. chem. Ind.*, 1945, **64**, 296.—Experiments show that impregnation of sacking with amounts of D.D.T. of the order of 1% effects a considerable measure of control on certain pests of stored products. *Calandra oryzae* and *Tribolium confusum* die after only a short exposure. *Ptinus tectus* is much more resistant, but control is effected by reducing the rate of reproduction and prolonged exposure appears to be fatal. C. F. M.

## Derived Chemical Products.

**315. Ethyl Alcohol made from Refinery Ethylene.** Anon. *Chem. Met. Eng.*, 1945, **52**, 96.—In 1935 the Standard Alcohol Co. developed a process for the hydration of refinery ethylene, and eight years later, in collaboration with the Standard Oil Development Co., designed and constructed a large-scale plant at Baton Rouge for the manufacture of 190–192 proof EtOH. In this, ethylene produced from the cracking of ethane-propane stock is, after suitable purification, contacted with 90% strength $H_2SO_4$ in an absorber. The resulting mono- and diethyl sulphates are hydrolyzed with water to ethanol and the crude product processed on a stripper from which aqueous alcohol, ether, and a small amount of acidic material are taken off overhead, and water and acid as a bottom product. The distillate is scrubbed with soda, and the ether separated from the aqueous alcohol on an ether-stripper. Any alcohol in the ether is extracted with water, the washings being admixed with the bulk of the ether-free alcohol and the whole fed to an efficient fractionating column. The 95–96% pure ethanol obtained from the latter is next denatured. A feature of the process is the process for recovery of concentrated $H_2SO_4$ from the dilute solution obtained at the crude alcohol stripper. This is initially concentrated to 70% strength in a reboiler. Further concentration is effected on a Simonson–Mantius two-stage vacuum acid concentrator, the first stage operating at an absolute pressure of 2·5 in mercury and the second at 0·4 in mercury. The concentrators are vertical cylinders, heated by Dowtherm A (20 p.s.i.) supplied to Hastelloy D tubes inserted through the walls of the vessels. A flowsheet of the process is provided, and various sections of the plant are illustrated by photographs. L. B.

**316. Synthetics from Petroleum.** B. H. Weil. *Petrol. Engr.*, May 1945, **16** (8), 198.—The position of the petroleum and chemical industries in respect of the production of chemicals from petroleum gases, etc., is surveyed and the possibilities and prospects discussed. The simple chemicals first produced at refineries included ethanol, isopropanol, ethylene glycol, acetone, etc. U.S. Tariff Commission figures are given for 1943 for several important chemicals produced from petroleum (See Abstract 521, 1945). The gases from thermal cracking are compared with those from catalytic operations. The latter contain about half the ethylene and from three to five times the propylene that thermal gases do, and as the yields of $C_3$ and lighter products are from 6% to 14·5% of the feed stocks, and the $C_4$ fraction (5–12·8% of the charge) contains about 32% of $C_4$ olefins, vast amounts of olefins could be available for conversion into chemical products. At one refinery alone the catalytic gases contain 75,000 lb ethylene and 300,000 lb propylene/day.

Products other than gases are also sources for chemical production, *e.g.*, cracked kerosine cuts for making detergents; naphthas also are extracted for toluene, which considerably augmented war supplies.

The various petroleum and chemical firms manufacturing chemicals from petroleum products are discussed, but the total production probably does not exceed 1% of the outputs, excluding butadiene and aviation gasoline components. Brief descriptions of the final synthetics and their uses and outlines of the product transformed are given with respect to the following: polyethylene resins (polythene); two allyl plastics, from propylene (a diallyl phthalate polymer and " Allymer C.R. 39 "); polyvinylidine chloride resins (" Saran "); a vinylidine chloride-vinyl chloride co-polymer (" Plioflex "); Geon resins, a similar co-polymer. A process is mentioned which produces trichlorethane which is easily converted into vinylidine chloride. An outline is given of other plastics derived, at least in part, from petroleum, including styrene, the acrylic resins (Plexiglas and Lucite), ethyl cellulose and (at least potentially), nylon phenolic and urea plastics. A table of such materials derivable from petroleum or natural gas is given. A plant is building for production of phthalic anhydride for the synthesis of phthalic alkyd resins, and a promising process for manufacturing carbon disulphide is announced; another process is for producing thiophene at an economic price, and developments are under way for the manufacture of ethylene oxide, acetic and maleic anhydrides. The more important processes for ammonia, methanol, and carbon blacks are surveyed. It is anticipated that at the end of the war production of carbon blacks will be over 1,000 million lb/year, roughly half being furnace-type blacks, which are satisfactory for synthetic rubber, but little used so far with natural rubber. One company has constructed a plant to produce blacks from degraded oils. A brief survey is given of the synthetics used as aviation components and synthetic rubber. The alkylates and butadiene are the two synthetics in greatest world-wide production.

W. H. C.

**317. Chemical Utilization of Natural Gas.** B. Miller. *Petrol. Engr*, May 1945, **16** (8), 216.—A report to the Technical and Research Committee, Nat. Gas. Dept., American Gas Assoc. The constituents of natural gas are outlined and the wartime utilization of the vast production amounting to four trillion cu ft per year (weight equivalent to 100 million tons) is reviewed and possible developments are surveyed from an economic viewpoint. Several important uses for the helium occasionally found in natural gas are described. The main portion of the paper relates to the manufacture of carbon black, and the several methods of its manufacture are discussed from the aspects of yields, qualities and applications of the types produced, and the economics of manufacture at source and places nearer the markets. The channel process produces less than 5%, channel blacks which are more suitable for compounding with natural rubber than with synthetic. Furnace production of carbon blacks gives yields of 25% or higher, furnace-type blacks possess properties which make them more suitable for synthetic rubber compounding for tyre manufacture than for natural rubber. Thermal decomposition processes can be operated so that no combustion products are associated with the carbon black. There are various modifications of this method, and the products have properties differing from the channel and furnace blacks, and also among themselves the uses of these thermal blacks have also increased. Hydrogen is produced during thermal decomposition of natural gas. The various types of carbon blacks are not completely changeable, and price differentials therefore exist and can be maintained. Accordingly, research is stimulated both from

the producer's and consumer's aspects. These economics are discoursed as to location and type of production, and tied in with higher yields and less gas consumed and the requirements of hydrogen obtained from thermal operations for hydrogenation and other purposes—*e.g.*, ammonia synthesis. Other possibilities are widely discussed. Aviation gasoline production, in relation to the use of products from natural gas. Post-war needs, it is considered, will be only 10% of peak war production. The use of natural gas plays but a minor part in synthetic rubber production. Other non-fuel uses which are expected to increase in quantity and importance are described and discussed: chlorinated hydrocarbons for solvents, etc., nitroparaffins, which may be starting points for a large variety of chemicals, and many oxygenated compounds. A successful process is noted which, by controlled air oxidation of natural gases, gives principally formaldehyde and methanol, and also acetaldehyde and other minor products; a commercial process produces principally acetic acid, a starting point for acetate-type synthetic fibres and plastics; another plant is stated to produce butadiene —it employs the aldol reaction. Aldol can be prepared from natural gas by a process involving partial oxidation. Another possible use for natural gas may yet be found in the Fischer–Tropsch syntheses if the developments anticipated by the Fischer-Tropsch enthusiasts are realized. W. H. C.

## Coal, Shale and Peat.

**318. Ester Waxes from British Lignite and Peat.** C. M. Cawley and J. G. King. *J. Soc. chem. Ind.*, 1945, **64**, 237–242.—During the war the Fuel Research Station undertook an investigation on the possibility of extracting from British lignite and peat a substitute for German montan wax. The extraction of wax from Devon lignite and various English and Scottish peats was studied, and lignite wax extracted with benzole was found to provide a satisfactory substitute of melting point 76–82° C. The yield averages about 5% of the dry lignite. The paper gives an account of the method of extraction and the effect of using different solvents on the yield and properties of the extracted ester waxes. Peat wax differs from lignite wax in being softer in texture, in having a melting point 10–15° C lower and higher acid and ester values. F. J. W.

**319. Charcoal Briquettes as a Coal Substitute.** H. Greene and T. N. Jewitt. *J. Soc. chem. Ind.*, 1945, **64**, 265–271.—A detailed account of work carried out in the Sudan on the production of a substitute for coal by briquetting a cold wet charcoal-pitch mixture. Gum arabic was used as a primary binder, and in some experiments the briquettes were impregnated with oil. C. F. M.

## Miscellaneous Products.

**320. Redwood Products as Inhibitors of Oxidation in *cyclo*Hexene and Gasoline.** H. F. Lewis, M. A. Buchanan, E. F. Kurth, and O. Fronmuller. *Industr. Engng. Chem.*, Nov. 1945, **37** (11), 1108–1112.—Solvent-purified redwood tannins are effective in preventing the oxidation of *cyclo*hexene but are of little value in protecting gasoline because of their solubility characteristics. Products prepared by the reaction of tannin with benzoyl chloride, caproyl chloride, chloroacetic acid, formaldehyde, and amines are not satisfactory as antioxidants. Condensation of tannin with acetone or other ketone results in a good yield of ether-soluble products which are good inhibitors for *cyclo*hexene, but the addition of water to the treated *cyclo*hexene results in the loss of approximately half the inhibiting action. The acetone–tannin condensation products have poor solubility in gasoline and are of questionable value as gasoline antioxidants. Products obtained by condensing catechol with acetone have excellent inhibiting properties for *cyclo*hexene and appear more promising as antioxidants for gasoline. A. W.

## Miscellaneous.

**321. Fiscal Support for Manufacture of British Petroleum-Chemicals.** Anon. *Petrol. Times*, 8.12.45, **49**, 1031.—The text of the clauses in the Finance Bill (No. 2) 1945 governing amendment as to duty on oils used in British refineries as raw materials in chemical synthesis is given together with a Government explanation. In brief, the act makes provision for the importation of hydrocarbon oils which are to be used for chemical synthesis free of duty or arranges for its rebate in cases where duty has already been paid. T. M. B. M.

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## OILFIELD EXPLORATION AND EXPLOITATION.

### Geology.

**322. Alabama : its Geology and Oil Prospects.** W. B. Jones, *Oil Wkly*, 14.1.46, **120** (7), 51.—In Northern Alabama is a Palæozoic area with Cambrian to Carboniferous beds. The east-central area consists of crystalline rocks, mostly pre-Cambrian, while the Coastal Plain had Cretaceous and Tertiary beds resting on Palæozoic and crystalline rocks.

The southwestern terminus of the Appalachians plunges beneath the Coastal Plain beds as a series of deeply eroded, sharply folded anticlines, separated by broad synclines. This region does not seem likely to produce oil or gas. Flat or gently warped Palæozoics make up the Tennessee Valley, the Plateau region, and the Warrior coal-field. In the north are Mississippian asphaltic limestone (Gasper) and sandstone (Hartselle). The Bangor limestone has crude in cavities, and all three horizons are potential producers at depth. The Pennysylvanian holds possibilities. About 75 wells have been drilled in this area, all having had oil- or gas-showings. Small amounts of gas have been produced. Cretaceous beds lap on to the preceding area. They have oil and gas possibilities. Subsurface structure is masked; geophysics and core-drilling will be required to decipher it.

In the southeastern part of the State Tertiary beds occur, and these give adequate cover for potential oil and gas horizons, such as the Tuscaloosa and Eutaw. The Hatchetigbee anticline has provided an oilfield on its southwest flank. Piercement-type salt-domes are to be expected in the western part of the region, and salt-beds or plugs have been encountered in two deep wells. The Jackson and Bethel faults may be due to differential settling or to breaks along the steep margin of an old shoreline.

In southwestern Alabama there are Miocene and Quaternary beds.

The first producing well of the Gilbertown field was completed in 1944. A total of 24 producers yield about 1800 brl/day of 19-gravity oil. Production is along a fault-plane in the Selma chalk at about 2800 ft, or in the Eutaw sands at about 3400 ft. The Eutaw sand is rather tight. Ultimately the field may yield 4000–5000 brl/day.

G. D. H.

**323. New Oil-field Apparently Assured in Venezuela Greater Oficina District.** Anon. *Oil Wkly*, 17.12.45, **120** (3), 71.—The Nipa 1 wildcat 5½ ml northwest of the West Guara field, and north of Oficina, was drilled to 9080 ft. On perforating at 7125–7135 ft it flowed 320 brl/day of 41·6-gravity oil, through a $\frac{4}{64}$-in choke. The G.O.R. was 10,500.

Tacata 1, in Monagas, 3 ml west of the Capacho discovery, has tested salt water at 7960–7970 ft. In the Tascabana 1 wildcat, 8 ml north of Oficina, a test at 7960–7970 ft is reported to have given 3,000,000 cu ft of gas/day, with some distillate and salt water.

The La Ceiba 1 wildcat, 19 ml northeast of the Santa Rosa field, is coring below 9250 ft. A number of interesting sands were found above 8500 ft.

The third well in the new Mara field of northwest Venezuela has flowed over 1000 brl/day, from the Cretaceous at about 6600 ft.

G. D. H.

**324. West Guara (Venezuela) Field Development.** G. O. Ives. *Oil Wkly*, 3.12.45, **120** (1), 16 (International Section).—West Guara is in the Greater Oficina area. It was discovered by slim-hole structure drilling, after seismic work had indicated the presence of an anomaly. The field was opened in June 1942. By October 1944 the production was 1,400,000 brl/month. The field is now fairly well defined by 97 producers and one dry hole. 29 wells are triple-zone producers, and many dual-zone producers will be converted to triple-zone wells. The output in these triple-zone completions is 450–500 brl/day/sand. The field covers 3500 acres. 39 separate sands have been tested, a good proportion of them extending over the whole field. Oil gravities range 8–57°, the 57° oil being black and flowing with G.O.R.'s of 450–800 on a ½-in choke. The top oil is 20°-gravity; then down to 6250 ft the gravity is 43–53°; below 6250 ft there is a decrease down to 8–10° at 7900 ft. For oils lower than 30° the gravity may vary as much as 10° with structural position.

There is a major fault on the south running N.E.-S.W. The throw is about 450 ft, and downwards on the up-dip side. The field is 7½ km long and about 1½ km wide. The basement is about 8000 ft deep. There is natural flow from the Miocene producing sands. A 5400-ft well may penetrate 12–14 sands, with a combined effective thickness of 185–250 ft.

Drilling conditions are almost ideal. Rigs are skidded from location to location.

G. D. H.

**325. Production Indicated for Northwestern Colombia.** Anon. *Oil Wkly*, 14.1.46, **120** (7), 70.—After failing to produce from deeper horizons, Floresanto 1 is swabbing oil from 620–650 ft. Floresanto 4 is testing showings encountered in drilling to 1504 ft. G. D. H.

**326. Conflicting Reports Received about Shell's Wildcat in Eastern Ecuador.** Anon. *Oil Wkly*, 10.12.45, **120** (2), 28.—Shell's Vuano 1 test is 80 ml southeast of Quito, near Arajuno. Some reports suggest that tests have given satisfactory amounts of oil, while others report oil-shows which are not very encouraging. The test is east of the Andes, 500 ml northwest of the Ganso Azul field of Peru. This produces from the Lower Cretaceous at 1174 ft on a structure 16 ml long and 7 ml wide, with 3600 ft of closure. G. D. H.

**327. Shell Abandons Test in Oriente of Ecuador.** Anon. *Oil Gas J.*, 5.1.46, **44** (35), 44.—Shell has abandoned 1 Vuano at about 5300 ft. It lies southeast of Quito.

Ecuador produced 668,051 brl of oil in the third quarter of 1945; the corresponding figure for 1944 was 749,943 brl. G. D. H.

**328. Chilean Test Well Points to End of Petroleum Imports.** Anon. *Oil Gas J.*, 12.1.6, **44** (36), 60.—The Spring Hill test well, north of Tierra del Fuego, is reported to have a daily production of 2000 cu.m. Its depth is about 7400 ft. G. D. H.

**329. Province of Drenthe in Holland Holds Interest.** Anon. *Oil Wkly*, 10.12.45, **120** (2), 65).—Prospecting is going on in the region of Schoonebek and Coe Vorden, Province of Drenthe, Holland, where the Germans drilled three tests. In June one well was producing 260 brl/day from a depth of 2500 ft. G. D. H.

**330. Oil Reported Discovered in Upper Part of Austria.** Anon. *Oil Wkly*, 3.12.45, **120** (1), 50 (International Section).—Oil is reported to have been discovered at Pergern, 18 ml S.E. of Linz. It is near Wels Heath, which has yielded natural gas. G. D. H.

**331. Good Producer Reported on West Caspian Coast.** Anon. *Oil Wkly*, 10.12.45, **120** (2), 65.—A 3750-brl well has been completed at Mahach-Kala on the west coast of the Caspian. G. D. H.

**332. Discovery of New Field in Russia is Indicated.** Anon. *Oil Wkly*, 14.1.46, **120** (7), 70.—An oil well yielding 170 m. tons/day is reported in a new discovery in the general area of Krasnokamsk (Severokamsk field). G. D. H.

**333. Oil and China's Future.** L. J. Logan. *Oil Wkly*, 3.12.45, **120** (1), 37 (International Section).—There is much prospective oil-bearing land in China, for there are large expanses of country with favourable sedimentary conditions, many anticlines and evidences of oil. Wu Su, in northwest Sinkiang Province, was the first commercial oil-field discovered in China, 25 producing wells were drilled, obtaining 49 to 52-gravity oil from about 4800 ft. This field is west of Tihwa.

The Yumen field of northwest Kansu Province lies between Yumen and Kiayukwan. The field was opened in 1939. There are 26 producing wells in a proved area of 3000 acres. Production is 21,000 brl/day. The 38-gravity oil comes from the Cretaceous at about 1350 ft. Oil seepages led to the discovery.

The Red Basin is favourable from the point of view of oil occurrence. There are many anticlines and many brine wells that have yielded small amounts of oil and gas from Cretaceous, Jurassic, and Triassic formations at shallow depths. The Permian and perhaps the Ordovician and Cambrian may have better oil possibilities. 4 ml southwest of Chungking a gas-producer was completed in a Lower Triassic limestone at 3300 ft. The pressure was 1200 lb/sq. in. 60 ml to the north another structure marked by oil- and gas-seeps has provided a high-pressure gas producer in the Triassic.

In Kweichow Province there are oil-impregnated Permo-Triassic beds 10 ml, southeast of Kweiyang. A Permian seepage has been found in Chekiang Province, below Shanghai.

Even in the most promising areas there has been little drilling. G. D. H.

**334. Australia's Deep Test Reported at 6765 ft.** Anon. *Oil Wkly*, 24.12.45, **120** (4), 70.—Western Petroleum's test at Nelson, Victoria, is reported to have reached 6765 ft. New equipment is to be considered for Freney Kimberley Oil's test, which was suspended at 4271 ft in 1942. G. D. H.

**335. Oil in the Arctic.** A. R. McTee. *Oil Wkly*, 3.12.45, **120** (1), 3 (International Section).—At Umiat, Alaska, a well has been drilled to 1816 ft, and 4 separate sands have been met, each of which shows enough oil to encourage further drilling. It is hoped to continue the well to 7000 ft.

The problem of transport, housing, and drilling in the Arctic are described in fair detail. G. D. H.

## Drilling.

**336. New Mechanical Rotary Drilling Rig.** Anon. *Petrol. Engr*, Dec. 1945, **17** (3), 130.—A new mechanical rig is described and illustrated with photographs and a layout plan. A few of the rig's specifications follows: (1) Depths of 10,000 ft with 4½-in drill pipe are recommended; (2) 3 engines with a combined input of 750 h.p. may be used; (3) the rig is rated at 750 h.p., 7500 ft-lb torque; (4) multiple-strand chain drives enclosed in dust-proof, oil-bath housings are supplied. V-belt drives are also enclosed; (5) the transmission unit has 3 forward and 1 reverse speed; (6) The rig has high- and low-speed drives from the lineshaft. These drives combined with the transmission speeds give a total of 6 forward and 2 reverse speeds to the drum, and 3 forward and 1 reverse to the rotary table; (7) the drumshaft is 7½-in diameter; the lineshaft is 6½-in in diameter, and the rotary countershaft is 6½-in in diameter; (8) all clutches are controlled by compressed air, and are of internal expanding design. The low drum drive is equipped with a multi-jaw emergency clutch; (9) the hoist is equipped with a 24-in by 32-in special alloy steel drum with 10-in by 16-in brakes that are watercooled, torque equalized, micro-sensitized, and have an area of contact of 2170 sq. in. The coefficient of holding power is estimated to be 69 to 1. A few operating data are given. A. H. N.

**337. Deep Sea Drilling.** R. D. Shrewsbury. *Oil Wkly*, 10.12.45, **120** (2), 33–36.—A proposed design for building a " Shrewsbury Column " in the form of pressurized deep-sea chamber sealed against the sea and drilling deep wells from the bottom of the sea is described. Many of the ideas are still in the formulative stage, but diagrams and probable estimates and solutions for the various problems raised are presented. A. H. N.

**338. Field Safety Programme Developed by American Association of Oilwell Drilling Contractors.** Anon. *Petrol. Engr*, Dec. 1945, **17** (3), 88.—The American Association of Oilwell Drilling Contractors have called a conference on safety in drilling, and have launched a monthly bulletin, *Safety Hints on Drilling*, and published a book, *Safety Manual for Rotary Drilling and Procedure for Operating Field Safety Programme*.

Among the safety hints on drilling, the drilling contractors are advised to follow the rules listed: (1) provide safe drilling equipment and tools; (2) safeguard all machinery; (3) place no new machinery or equipment in operation unless full attention has been paid to its safety and crews trained to use it; (4) plan and arrange all drilling operations with careful attention to safety; (5) maintain a system of rig, equipment, and tool inspection to discover correctible hazards; (6) maintain safety-minded supervisors; (7) train, educate, and stimulate its employees to follow safe methods of work and to take a sincere interest in the safety of themselves and their fellow-workers; (8) investigate each and every accident to determine how best to prevent a recurrence; (9) make full and prompt report to the proper authorities of all cases of injury. A. H. N.

**339. Cement Substitutes for Elimination of Water.** C. E. Clason. *Oil Wkly*, 10.12.45, **120** (2), 54.—The need for a seal which is a true solution and not a suspensoid or colloidal dispersion in certain cases is explained. Certain patented materials called Resinite Seal have been used successfully. Resinite Seal of one type is particularly suitable for pure sandstone formations with a range in bottom-hole temperature of from 70° to 220° F. This product has been used in the East Texas Woodbine sand with

marked success in plugging off bottom-hole water where the average formation temperature is 145° F. Other applications have been made in the Talco-Paluxy sand at 156° to 162° F. Many jobs have also been done in Pennsylvania, Oklahoma, Kansas, West Texas, and Illinois. The equipment in use consists of a dump bailer truck, a special dump bailer such as is used in gypsum cement work, and in some places, where needed, a winch line. Measuring lines, etc., and other devices common to bottom-hole work are also used. Rapid portable mixers and containers are part of the setup. This resin in its set condition has an ultimate compressive strength of from 12,000 to 15,000 lb/sq. in. The tensile strength is from 5000 to 9000 lb. These strengths are far greater than is actually necessary to accomplish the desired effect. In both fluid and solid phases, the sp. gr. is 1·201, which is 10·02 lb/gal. (U.S.). A. H. N.

**340. Determining Minimum Cement Waiting Time.** R. F. Farris. *Oil Wkly*, 7.1.46, **120** (6), 30. *Digest of Paper presented before American Institute of Mining and Metallurgical Engineers.*—To determine what strength the cement should have to support whatever amount of casing weight might be applied to it, laboratory determinations were made with pieces of 5½-in outside diameter casing, each set in cement inside of 9½-in outside diameter pipe. Five-foot lengths of pipe were used in each case, and standard cement slurry weighing 15·6 lb/gal was poured into the annulus of each unit to a height of 4 ft. The lengthwise bonding strength of the cement to the casing was determined at various time intervals by measuring the force which had to be applied to the end of the 5½-in pipe to move it with respect to the outside or 9½-in pipe. Each time the bonding strength of the cement in the annulus was tested, observations were also made of the strength of the cement briquettes and the progress towards the initial and final set. These data are shown graphically. When these data are used to calculate the vertical length of casing represented by a weight equal to a given bonding strength, it is found that a given length of cement, having reached a relatively low tensile strength at the beginning of its final set, can support the weight of 100 to 200 times that length of uncemented casing.

Two methods of predicting cement strengths are described in some detail.

A. H. N.

**341. Special Diamond Coring Records Nearly 100 per cent in Lime Formations.** K. B. Barnes. *Oil Gas J.*, 24.11.45, **44** (29), 98–101.—During the last few months experimental coring of oil-productive limestones and dolomites has been done with diamond-faced core bits at four wells, with the recoveries being 83·8% of 57 ft cored, 96·5% of 347·5 ft, 81·1% of 60 ft, and 97·5% of 40·5 ft. Furthermore, the wells all were in "hard to core" formations and territory. 400 to 500 diamonds totalling 60 to 100 carats make up the facing of the special core-heads. The diamonds are cast in place, rather than being individually inserted and set in the facing. A steel "blank" is made to comprise the upper part of the head and the joint. The blank is then suspended in a female mould in which the individual stones have been positioned by hand, and the matrix metal (an aluminium-bronze alloy) poured in. This casted bond forms the diamond crown. The tool is illustrated together with its characteristics. Concensus of those engaged in the four tests was that diamond coring is useful in special situations where the fragmental, vugular, or erratic porosity in limes has to be cored with a light weight scraping action to attain high recoveries, and where for special geological and reservoir study purposes the cost is warranted. The work also proved that diamond coring could be satisfactorily accomplished and high recoveries obtained without the use of hydraulic feeding equipment and with standard rotary tools, provided the equipment was in good mechanical condition and normal working ratings not exceeded. A. H. N.

## Production.

**342. Measuring Distribution of Liquids in Flowstring of a Gas-Condensate Well.**—C. K. Eilerts, R. V. Smith, and V. L. Barr. *Oil Gas J.*, 15.12.45, **44** (32), 91.—The Bureau of Mines, in co-operation with the Natural Gasoline Association of America and the American Gas Association, is investigating means of preventing the serious corrosion to which some high-pressure, gas-condensate wells in the Gulf Coast area are subject. Samples in the fluid from these wells are being studied in the laboratory to ascertain the nature of the corrosion and to find inhibitors that will minimize its effects. Alloys

are being compared as to composition, fabrication, and resistance to corrosion for the purpose of finding economically feasible materials for making equipment to be used on the wells. Water has an important rôle in gas-condensate well corrosion, and portable equipment has been constructed and used in the field to measure the distribution of water in the tubing of a flowing well. The amount of water present at a given point in the flow-string is significant because it may control rates of corrosion and also determine the effectiveness of inhibitors. The sampling and analyzing of the analyses of hydrocarbon liquid/gas ratios and of water liquid/gas ratios are given graphically. Liquid water was found in a certain minimum ratio throughout the strings.

A. H. N

**343. The Optimum Rate of Production.** Part 13. P. J. Jones. *Oil Gas J.*, 24.11.45, **44** (29), 102.—Let the per-well rate of production be uniform during a period of development. Then the rate of development of a reservoir is equal to the rate of increase of the rate of production. Rates of development vary widely as between reservoirs from a slow initial rate up to a comparatively fast initial rate. A slow initial rate of development may be represented by rates of production proportional to cumulative recovery. A rapid initial rate of development may be represented by rates of development inversely proportional to the rate of production. The rates of development found in practice are likely to fall between these two limits. The characteristics of several types of development programmes as to rates of production and cumulative recovery are illustrated graphically. A fixed number of rigs and a uniform per-well rig time represents a uniform rate of development, uniformly increasing rates of production. The procedure for estimating the present value of the production accumulated during a period of development is illustrated by an example for uniformly increasing rates of production

A. H. N.

**344. The Optimum Rate of Production.** Part 14. P. J. Jones. *Oil Gas J.*, 1.12.45, **44** (30), 87.—The reserve recoverable before the rate of production from reservoirs starts declining depends on the initial well-producing capacity, the rate of decline of well-producing capacity, and on the rate of production. Other things equal, the initial well-producing capacity depends primarily on the number of wells drilled. The decline of well-producing capacity depends on producing and operating methods. The reserve recoverable before production starts declining with a fixed number of wells and given producing and operating methods varies with the rate of production from reservoirs. The slower the rate of production, the higher the reserve recoverable before production starts declining. These points are illustrated graphically, and by examples. In the case of oil reservoirs, the drilling of a comparatively large number of wells may cost more, as a rule, than injection of gas or water. The drilling of a comparatively large number of wells does not increase the barrels of ultimately recoverable oil. It increases well-producing capacity and the fraction of a fixed initial oil reserve, which is recoverable before the rate of production starts declining. The foregoing considerations may influence optimum rates of production through investments, operating expenses, or size of reserve.

A. H. N.

**345. The Optimum Rate of Production.** Part 15. P. J. Jones. *Oil Gas J.*, 8.12.45, **44** (31), 105.—Declining rates of production may be classified according to rates of depletion. The ratio of producing rate to reserve is the rate of depletion. This ratio, the rate of depletion, may be either uniform or variable. A declining rate of production proportional to reserve is a uniform rate of depletion. A declining rate of production not proportional to reserve is either an increasing, or a decreasing, rate of depletion. This article is limited to uniform rates of depletion. The following characteristics for uniform rates of depletion are illustrated graphically and by examples: (*a*) Rates of production; (*b*) cumulative recovery; (*c*) annual rate of decline; (*d*) average annual rate of decline; (*e*) average annual decline; (*f*) reserve factors; and (*g*) the number of years required to accumulate a reserve at various rates of depletion. Uniform rates of depletion will be used later to estimate the optimum rate of production for the reserve recoverable at declining rates of production.

A. H. N.

**346. The Optimum Rate of Production.** Part 16. P. J. Jones. *Oil Gas J.*, 15.12.45, **44** (32), 116.—Declining rates of production may be accompanied by increasing, uniform, or decreasing rates of depletion. Cycling operations and pressure mainten-

ance projects are usually conducted at increasing rates of depletion. The rate of depletion, at the time the rate of production from a reservoir starts declining, is equal to the ratio of cumulative recovery and the product which results when reserve is multiplied by the number of years during which the recovery was accumulated. If the subsequent rates of depletion are uniform, this ratio is also equal to the prospective rate of production decline. But if the subsequent rates of depletion are not uniform, the prospective rates of production decline are variable. Variable rates of depletion are either increasing or decreasing rates of depletion. This article defines the limiting rates of production which represent increasing rates of depletion. The optimum rate of production for increasing rates of depletion is different from the optimum rate of production for increasing rates of depletion. For this reason, it is desirable to define the rates of production which represent increasing rates of depletion. A. H. N.

**347. The Optimum Rate of Production.** Part 19. P. J. Jones. *Oil Gas J.*, 5.1.46, **44** (35), 60.—Economic limits depend on producing and operating methods. The effect of economic limits on estimates of optimum rates of production from reservoirs to be developed may be neglected as a rule. However, estimates of optimum rates of gas, or water, injection into partly depleted oil reservoirs should be made in terms of economic limits as a rule. If an economic limit is of the order 1% or higher of the rate of production at a given time, estimates of reserves and of prospective rates or production are likely to be more accurate if made in terms of economic limits. These considerations are illustrated by examples. A. H. N.

**348. The Behaviour of Water-Input Wells.** Part III. P. A. Dickey and K. H. Andresen. *Oil Wkly.*, 3.12.45, **120** (1), 14. *Paper presented before American Petroleum Institute.*—In this part the plugging effects of suspended and dissolved matter and of organic growths on input well behaviour are detailed. In general it is found that materials of smallest diameters are of greatest plugging effect. Selective plugging is discussed, together with the results obtained with two patented methods. The use of fine suspended matter in a carrier fluid is found effective in certain selective plugging operations. A. H. N.

**349. Behaviour of Water-Input Wells.** Part IV. R. A. Dickey and K. H. Andresen. *Oil Wkly.* 10.12.45, **120** (2), 43. *Paper presented before American Petroleum Institute.*—In this part the phenomenon of formation rupture or " breakthrough " is discussed. The critical pressure at the sand face ranges between 1·0 and 1·7 psi/ft of depth in the northwestern Pennsylvania and eastern Illinois fields. Values for other fields also fall within this range, although there is insufficient information definitely to establish the range for each of them. The range of critical pressures cited applies to depths between 260 and 2075 ft. Critical pressures vary from well to well, and in one area (east of Rixford) in the Bradford field the critical pressures appear to be abnormally low, and of the order of 0·9 psi/ft of depth or less. Apparently the critical pressure is lower in the early life of a well than it is after a considerable volume of water has been injected into the surrounding sand. If, after a breakthrough has occurred, the pressure is reduced below the critical value, sometimes the well resumes its normal water-intake rate, but, if the critical pressure has been exceeded for several days or weeks, the wells usually do not resume their previous water-intake rates, but continue to take water at a high rate, which fluctuates in an irregular manner. Breakthroughs are almost always followed by the appearance of water in one or more neighbouring oil-producing wells within a few days, and the water passes quickly from one well to another. Breakthroughs are characterized by definite increases in injectivity indices. The increase in the value of the index is never gradual, and the graphs of the pressure-input points are straight lines with sharp discontinuities. The mechanism of rupture and its effects are detailed. A. H. N.

**350. The Optimum Rate of Production.** Part 17. P. J. Jones. *Oil Gas J.*, 22.12.45, **44** (33), 63.—The production characteristics for increasing rates of depletion are reviewed in this article. The rates of production and cumulative recovery corresponding to increasing rates of depletion are illustrated graphically and by examples. The rate of production decline increases for increasing rates of depletion. The average annual rate of production decline and the average annual decline

of production increase for increasing rates of depletion. The significant characteristic of increasing rates of depletion is the increase of: (1) the rate of decline; (2) the average annual rate of decline; and (3) the average annual decline. The value of properties and the advisability of additional investment in reservoirs depend on the prospective rates of production decline. The rate of production decline may increase abruptly for increasing rates of depletion. A. H. N.

**351. Lake Creek Cycling Project Example of Applied Engineering Technique.** E. H. Short, Jr. *Oil Gas J.*, 1.12.45, **44** (30), 64.—The field is producing from seven zones by means of single, dual, and triple completion wells, some of which are used as injection wells. A diagram of a peg-model illustrates the complexity of the problem, and the paper discusses some engineering aspects of the production of the various zones. A. H. N.

**352. Mobile Unit Provides Individual Well Data.** H. A. Hess. *Oil Wkly*, 17.12.45, **120** (3), 66–67.—A portable unit incorporating a separator, oil meter, gas meter, and an automatic sampler for salt-water determination has been perfected and placed in mass production by a Houston concern. The unit is described. A. H. N.

**353. Determining Weighted Average Bottom-Hole Pressure in East Texas Field.** L. J. Meyer. *Oil Gas J.*, 1.12.45, **44** (30), 67.—Tread of reservoir pressure with production is a very important relationship in any pool. Because of the large area, number of wells, and reserve of the East Texas field, probably more bottom-hole-pressure tests and interpretative studies of pressure data have been made there than in any other single field. This paper presented the detailed procedure for the determination of the weighted average bottom-hole pressure of the East Texas field as conducted by the Engineering Department. Oil and Gas Division of the Railroad Commission of Texas. The formulæ used are derived, and typical tables of data and results are given. A. H. N.

**354. Application of Laboratory Data on Phase Behaviour to Evaluation of Condensate Reserves.** E. W. McAllister. *Petrol Engr*, Dec. 1945, **17** (3), 90.—Although the phenomenon of retrograde condensation has been recognized in laboratory work for many years, there is still considerable lack of the specific information required properly to re-estimate the petroleum products that would be recovered from a condensate pool produced by straight-pressure depletion. This is due to the lack of laboratory equipment suitable for running condensation or phase behaviour experiments on samples involving a change in composition with decrease in pressure. This experiment involves withdrawing portions of the sample in the gas phase, causing each increment of pressure decrease and determining the composition of the portions of samples withdrawn and remaining. At present, nearly all laboratories are equipped to run phase behaviour experiments involving no change in composition of the sample and showing only the indicated relative volume of liquid condensed with change in pressure and without determining the composition of the liquid so condensed. Such data are suitable only for determining the products to be recovered at the dew-point pressure or above, with an indication of the magnitude of the rate of liquid condensation that may occur in the reservoir with pressure drop in the retrograde region. Examples of experiments with constant composition are illustrated and their results are discussed. The discussion involves graphical studies, and the original paper should be consulted for more details. A. H. N.

**355. West Edmond Salt-Water-Disposal Plant Initiates Service to Member Operators.** W. J. Davis. *Petrol. Engr*, Dec. 1945, **17** (3), 106.—Details of an organization of companies for salt-water disposal from their respective fields are described. The design and operation of the plant are discussed. Amongst the hydrodynamical principles of the settling plant the following have been found to be valid rules for design: (1) that a particle 0·01 mm in diam. is the smallest particle that can be economically removed without the addition of a coagulant; (2) that the falling rate of such a particle in still water is 0·005 ft/sec; (3) that a continuous-flow settling basin, properly baffled, is as effective in removing suspended matter as a series of intermittent settling basins; (4) effective settling may be accomplished when the mean velocity through the basin does not exceed 3 times the falling velocity of the particle to be

removed; (5) that the incoming and outgoing velocity of the fluid flowing through the basin can be as high as 25 times the mean permissible velocity; (6) that the detention time in a rectangular basin must be 3 times longer than in a circular basin in which radal flow is maintained, to allow for end currents; (7) that the working level of the fluid in a settling basin should not be less than 5 ft in order to insure quiet fluid, or more than 15 ft in depth, to insure maximum economical operation.

Mechanical and other operating details are given. A. H. N.

**356. Oil Yield/Acre-Foot may Guide Well Spacing.** K. M. Fagin. *Petrol. Engr.* Dec. 1945, **17** (3), 72.—Reasons for keeping ample records of field operations are detailed. Although the main purpose of developing these significant field-wide facts may be to enable the operator to forecast the probable future recovery from a new reservoir and the most effective and profitable well-spacing programme by comparison with the probable ultimate recovery per acre foot in older producing reservoirs with similar characteristics, the operator may use the facts in many other ways, such as: (1) to determine whether or not he is depleting the acre feet of producing formation under his leases as rapidly as the average acre foot in the field is being depleted; (2) to guide the preparation of estimates of recoverable oil reserves under his leases for tax or appraisal purposes; (3) to provide himself with a condensed history of the development and production progress of the field that will give clear and ample warning of impending operating difficulties that require budgeting, such as the need for installing pumps, the need for preparing for water encroachment, the need for remedial work on the wells, as well as the feasibility of pressure maintenance, repressuring, or waterflooding. A looseleaf ledger is described for these purposes. A typical field production data sheet is reproduced and many of the items included on the sheet are discussed.

A. H. N.

**357. Annulus Method of Locating Water in Oil Well.** J. S. Hagestad. *Petrol. Engr*, Dec. 1945, **17** (3), 198.—The determination of the entry of water into a well is usually done on a static well. The paper describes methods for determining water entry in a producing well without stopping it. In this method the tubing of a pumping well is raised and a bailer is used to place electrolytes at different points of the well, the bailer being lowered between the tubing and the casing. Detection of the electrolyte in the oil being pumped places the point of entry of the water. Typical cases are described.

A. H. N.

**358. Selective Acidization Procedures at Carthage Field Result in Great Productivity—Larger Ultimate Recovery.** N. Williams. *Oil Gas J.*, 22.12.45, **44** (33), 56–57.—Three of the four producing horizons of the Carthage gas-field in Panola County, Eastern Texas, consist of oolitic limestone formations in which acid treating of wells is a factor in developing maximum productive capacity. Since well potentials are a basis for allocations of allowable production, incentive is given for establishing the greatest productive capacity possible when completing wells. This has led to an acidization race among some operators in which relatively large volumes of acid have been utilized in many cases in attempts to increase the permeability of producing formations. Lately, however, the adoption of methods by which more effective placement of the acid can be attained, rather than increasing the volume, is receiving the consideration of operators. The general procedure, involving a squeeze cementation, is described, together with some interesting variants used when particular conditions requiring them are met in a well. Of interest in connection with squeezing practices in this field is the recent use of plastic in several wells. In one well this material was used exclusively, replacing cement not only for the initial "cementing" of the production casing string, but also for a succession of squeeze jobs. Its use is expected to prove especially advantageous in squeezing the interval between the Gloyd water sand and the Hill zone, as these upper formations are extremely unconsolidated and do not hold up, making it difficult to obtain a good cement job. With about 200 gal. of plastic squeezed into that interval satisfactory results have been realized. Packers are also used. A. H. N.

**359. Engineering Approach to Oil Reservoir Controls.** S. J. Pirson. *Oil Wkly*, 31.12.45, **120** (5), 22.—Scientific reservoir control presupposes the existence of reasonably accurate forecasting means of the expected performance of a field under existing

or preassumed conditions. It is necessarily predicated upon the knowledge of natural as well as artificial recovery mechanism or " drives " which are fundamentally three in number—viz. water drive, segregation drive, and depletion drive. The various drives are the object of modifications resulting from pattern flow, dips, connate water saturation, viscosity variations, rates of formation flow, and sand heterogeneity. The various recovery mechanisms have their specific degree of ultimate recovery. Accordingly, it is pertinent to gauge the degree of effectiveness of each mechanism in a field in order to predict the ultimate recovery. To this end the concept of a " Drive Index " is introduced, and it is shown how such an index may be computed for each type of drive from the material balance equation for either a current production practice or any presumed rate of withdrawal. As a result, the recovery programme may be engineered so as to favour one or more types of drive in order to secure maximum recovery through the prescription of the most efficient rate of production. Formulæ are derived and presented for water-drive index (W.D.I.), segregation drive index (S.D.I.), and depletion-drive index (D.D.I.). Examples are given to illustrate the use of these indices. A. H. N.

**360. Well Pulling Costs Cut by Time-saving Rack.** Anon. *Oil Wkly*, 24.12.45, **120** (4), 49.—Details of a tubing rack and of another for rods used to minimize time of pulling are given. A. H. N.

## Oilfield Development.

**361. 25,800 Completions Probable for 1945.** Anon. *Oil Wkly*, 17.12.45, **120** (3), 65.—The results of drilling in U.S.A. during the first 11 months of 1945 indicate that the year's total completions will number about 25,800 wells, including 400 old wells deepened.

In November the completion rate was 531 per week. The October figure was 501 per week. 23,711 wells were completed during the first 11 months of 1945. Texas completions were 20% above the 1944 level, Louisiana completions 38%, Oklahoma completions 29%, and Colorado completions 80%.

A table summarizes the U.S. completion results by States for November, 1945, and for the first 11 months of the year. G. D. H.

**362. Venezuela.** G. O. Ives. *Oil Wkly*, 3.12.45, **120** (1), 12 (International Section).—During the week ended October 13, Venezuela produced an average of 969,600 brl/day, thus exceeding the previous peak of 965,000 brl/day in the week ended August 13, 1945. The bulk of the output was from the Maracaibo Basin, where the flush production occurs 1–12 km offshore. A well is to be drilled in 90 ft of water on a concession in the centre of the lake.

Quiriquire produces 50,000 brl/day, and the single field extending westward from Jusepin through Mulata, Muri, and Santa Barbara to Travieso, gives 129,000 brl/day. In the Greater Oficina area are Oficina, Leona, East Guara, West Guara-Guico, and Yopales, all producing from sands of the same age, and of similar structural characteristics. The accumulation is due to normal faulting, and Oficina itself has at least a dozen blocks. The Greater Oficina area produces 100,000 brl/day, the bulk (2,000,000 brl/month) coming from West Guara's 3500 acres, while Oficina gives 1,250,000 brl/month from 12,275 acres.

A 16-in pipeline runs from Oficina to Puerto La Cruz, and a 16-in line from the Jusepin area to the same terminal. A 12-in line from the Santa Barbara field ends at Chaure. There is a 10-in line from Jusepin to Caripito, and 8-in and 10-in lines from Quiriquire to Caripito.

The San Joaquin, Guario, El Roble, Santa Ana, Rincon, and Santa Rosa fields are anticlinal or dome structures, whereas the Jusepin group is basically a series of stratigraphic traps with faulting, being formed by the wedge-out of the Miocene and other sands against the northern coast range of mountains. Production is largely from the Miocene in the San Joaquin area, while deep wells round Santa Rosa and El Roble have prospected the Eocene without yet establishing important production. This area produces 26,000 brl/day, San Joaquin providing about half the total. 225 km to the west is the Las Mercedes field, which lacks an outlet.

Lagunillas, Cabimas, Tia Juana, and Mene Grande are the principal producing areas of the Lake Maracaibo region. Their cumulative production to the beginning of

August 1945 was 2,346,141,340 brl. At the beginning of August Lagunillas was producing at the rate of 285,000 brl/day. Production is from the Miocene and Eocene, much of the offshore production being from the Eocene.

Until early 1945 the relatively unimportant fields of La Paz and La Concepcion produced from the Eocene. Early in 1944 Upper Cretaceous production was established at 4446 ft, about 1500 ft below the deepest Eocene pay. The initial well gave 800 brl/day, and a later well which reached 5397 ft, gave 4000 brl/day. It is hoped that this formation will produce elsewhere in the Maracaibo Basin below the Miocene and Eocene, although it may lie beyond the reach of present drilling techniques in most of the area. Cretaceous production has been found 33 km north of La Concepcion at 6011 ft.

Venezuela is capable of producing a million barrels of oil per day. G. D. H.

**363. Argentina Production Declines 5·6 Per Cent.** Anon. *Oil Gas J.*, 22.12.45, **44** (33), 46.—In the first six months of 1945 Argentina produced 11,569,832 brl of oil. G. D. H.

**364. Production in Ecuador Drops in Third Quarter of 1945.** Anon. *Oil Wkly*, 14.1.46, **120** (7), 70.—In the third quarter of 1945 Ecuador produced 668,051 brl of oil, 80,891 brl less than in the corresponding period of 1944, but 15,868 brl more than in the second quarter of 1945. G. D. H.

**365. Iranian Oil Production Hit New Record in 1944.** Anon. *Oil Gas J.*, 22.12.45, **44** (33), 46.—In 1944 the Iran oil production was 87,102,955 brl. Gach Saran produces about 15,120,000 brl/year. Agha Jari began producing in 1944. G. D. H.

## Transport and Storage.

**366. Pumping Various Products through the same Pipeline System.** J. M. Williams. *Oil Gas J.*, 22.9.45, **44** (20), 197.—New operating problems were created in the early 1930's when the first products pipelines were constructed, since they naturally differed from a crude-oil system in operating details and in their use for several grades. As a result of experimental work carried out mainly by Keystone Pipeline engineers, it was possible in 1940 to pump 8 grades of gasoline, 2 grades of kerosine, 2 grades of furnace oil and 1 grade of gas-oil, with each grade individually delivered ready for use to the main terminal points on the line. This article discusses the theory involved and the results obtained in transporting a wide range of products through the same trunk-line system.

Fluid motion through pipes is shown to depend to a large extent on the value of the expression (known as the Reynolds number) $\frac{Dv\delta}{\mu}$ when $D$ = pipe diameter, $V$ = velocity of the fluid, $\delta$ = density of the fluid and $\mu$ = its viscosity. The change from streamline to turbulent flow takes place when this expression is equal to approx 2000, and the length of the contamination stream where one liquid follows another in a pipeline is proportional to this quantity.

Much of the experimental work described was carried out using a 400-ft system of ½-in glass tubing where the liquid boundaries were always under inspection and their behaviour could be correlated with that expected from theoretical considerations. Samples could also be taken from various points on the line and examined for their extent of contamination. Contamination curves are given showing interface characteristics obtained with various mixtures of grades using both the miniature rig and 8-in pipe some 500 miles in length. T. M. B. M.

**367. Pipeline Coatings Tested for Dielectric Strength.** E. A. Koenig. *Oil Gas J.*, 22.9.45, **44** (20), 303.—A description is given of the application of protective coatings to pipelines, the best coatings to apply, and their testing by means of measurements of dielectric strength.

The necessity of coating pipelines is stressed, and the advantages of carrying out the coating process by machine is discussed. Good bonding with many primers is limited by slight traces of moisture, dust, grease, and light rust films, and therefore too much stress cannot be put on clean pipe. Pin holes and air bubbles are often formed in a hot coating application, and may be sealed over in the pipe coating which will appear

satisfactory. The use of a porous type wrapping such as Fiberglass assists in removing some of these defects, and samples prepared in the laboratory by dipping sheets of this material in the molten coating showed an increase in breakdown voltage (in volts per mil) as the thickness of the sample decreased indicating uniformity of the dielectric materials, and the high compatibility of the coating and the Fiberglass. Field tests subsequently showed the superiority of this material, and a 10-mile length of this coating on a pipe inspected after 6 years was found to be in excellent condition. Fiberglass has since been used for the protection of new and reconditioned lines varying in diameter from 4 to 24 in and of total length 120 miles. T. M. B. M.

**368. Rustless Pipe for War and Peace.** F. Squires. *Oil Gas J.*, 4.8.45, **44** (13), 70.—Details are given of investigations made by the Illinois Geological Suvey to find superior corrosion-resistant pipe materials. The most satisfactory materials were found to be: (1) coal-tar pitch with a binder of macerated paper and wood fibre; (2) cement with binder of asbestos fibres; and (3) both plain and reinforced plastics. Fibre pipes made of 75% coal-tar pitch and 25% macerated paper and wood fibres are manufactured in three grades for electric conduit work; the second-grade pipes, having a bursting pressure of 220 p.s.i., were joined together in different ways and subjected to mechanical and corrosion tests. Tapered ends driven into oppositely tapered couplings provide lines suitable for surface gravity lines; threaded pipes in threaded stainless steel or plastic couplings give non-corrodible lines suitable for surface lines and cemented-in casings for shallow wells. These lines, however, sag under their own weight and are susceptible to shocks from different sources which cause crazing and subsequent weakening. These faults can be corrected by either cement lining or inside reinforcement with coiled wire and cement lining. These methods increase the resistance to bursting and make them suitable for surface pressure lines.

The method of manufacture of asbestos-cement pipes of 200 p.s.i. bursting pressure is described; they are used for electric conduits, vent-pipes, and water-mains. Sections of these pipes were coupled up with seven kinds of joints, which are described and discussed. Their testing is described and the results are given and discussed. Threads of the asbestos-cement pipes are best cut by means of a grinding wheel; 4 threads on each pipe end are recommended. Rubber of fabric-graphite gaskets can be used.

Pipes made of highly compressed cement reinforced with glass fibres (termed "glasscrete"), on testing would not withstand shock and suddenly applied loads.

Asbestos-cement pipes may be threaded by grinding, and joined by stainless steel or plastic couplings to form a line strong enough to provide practical pressure surface lines, and may be cemented in a casing in wells of considerable depth for salt-water disposal. Trials with asbestos-cement pipes joined by plastic couplings either alone or reinforced by glass fibres or metal are described. The results show that the former were very successful, and that metal reinforcing of plastics has given very promising results. It is anticipated that great improvements may arise from further work in these directions. W. H. C.

**369. Alaskan Highway Oil Pipeline.** Anon. *Engineering*, 5.1.45, **159**, 1.—The pipeline was constructed to permit the direct distribution of fuel oil and gasoline to the Alaskan Highway and to airfields along the route. The previous route necessitated a long sea passage for tankers which, apart from curtailments due to bad weather, was vulnerable to submarine attack by the Japanese, who succeeded in destroying many ships.

The scheme was designed to relieve the supply position by running a pipeline from the existing oilfields at Norman Wells to Whitehorse, 600 miles away, and the nearest accessible point on the Highway. This necessitated crossing the Mackenzie Mountains, 5000 ft high. Climatic conditions were severe, ranging from 70° F below zero in winter, to 90° F in summer.

The Norman Wells crude is paraffinic, and of such quality that it may be used without refining as a diesel fuel. A small refinery at Norman Wells supplied the gasoline necessary for the construction work. Subsequently a new refinery was established at Whitehorse with a capacity of 3000 brl/day, crude being delivered via the pipeline from Norman Wells.

The pipeline from the refinery followed the Highway westward to Fairbanks (600 miles) and eastward to Watson Lake (300 miles). There was also a branch line to

Skagway, which could be used to supply tankers from Whitehorse or in reverse to supply gasoline shipped from other sources to Fairbanks, Whitehorse, and Watson Lake.

Pumping-stations are provided at approximately 50-ml intervals throughout the system of 1600 mls total length. The pipe varied in diameter according to the section and service from 2 to 6 in diameter. Lengths of from 30 to 40 ft are electrically welded together.

Work on the pipeline was started in 1942 and completed in 1944. The contractors had to overcome many natural and climatic obstacles, the supply of materials and equipment presenting many difficulties. A full description of the construction of this pipeline appeared in " Engineering News Record " dated May 18, 1944.

C. D. B.

**370. High-Pressure Gasoline Cable-type Pipelines under the English Channel.** V. A. Sheals. *Oil Gas J.*, 22.9.45, **44** (20), 205.—The historical events leading up to the construction of the pipelines under the channel are discussed, as well as the methods employed for its manufacture.

The idea was conceived by A. C. Hartley of the Anglo-Iranian Oil Co., and an experimental 2-in line designed and built by Siemens was installed for test in the Bristol Channel in December 1942. As a result of these tests, and in anticipation of D day, several British manufacturers started to build 3 in pipe in 1943, and in 1944 four American manufacturers were selected to assist in its manufacture. The design of the cable is given, and details as to the alloys used noted. The pipe was extruded in 2300-ft lengths on special large-diameter reels; photographs of the plant used are reproduced. The splicing process used for joining the lengths together is described, which operation took about 2 hours for each joint.

The first complete pipelines were laid from the Isle of Wight to Cherbourg, and later from Dungeness to Boulogne, distances of 66 and 29 miles respectively, the pipe being shipped in lengths of 35 and 70 nautical miles. The transport and shipping arrangements of the cable from the United States are given, and photographs of the gondola cars used are included.

Details of the results of endurance tests are listed, and in operation the lines had a very ample factor of safety. A total of 12 lines of HAIS cable pipe and 8 lines of 3-in welded steel (Hamel type) were installed, and approximately 1,000,000 gal of gasoline were pumped through the lines daily.

T. M. B. M.

**371. Technique for Determining Installation of Cathodic Units.** O. C. Mudd. *Oil Gas J.*, 22.9.45, **44** (20), 201.—The article discusses the method used for placing correctly the direct-current cathodic corrosion-preventing devices on pipelines as well as the correct location of insulating flanges.

Two gasoline-driven 2·5-kw, 50-amp, 50-volt generators (to develop up to 75 amp with corresponding voltage decrease) mounted on pneumatic-tyred trailers are used. An anode is inserted in the soil 300 to 400 ft from the pipeline, to a depth of 4 to 5 ft with electrolyte solution. The positive terminal of the generator is connected to this and the negative to the pipeline, operating the unit at the desired current output for 4–5 hr to polarize the adjacent pipe surface. Pipe to soil potential measurements are then made along the line by a copper sulphate half-cell electrode, progressing away from the unit connection and continuing beyond the point of minimum requirement to make sure that the limit of effective protection has been passed. The second unit is connected up similarly at a distance from the first of approximately three times the length of line found under effective protection (0·25 v min). Both units are then operated simultaneously for 4–5 hr, while pipe-to-soil potentials are taken from generator to generator to find if protection is complete. Insufficient protection between units requires moving the second nearer the first and repeating the test, while over-protection is not only uneconomical but may cause damage; 2·5 volts is the maximum allowable pipe to soil potential. After an intervening section is found to be satisfactorily protected, measurements are continued beyond the second unit by transferring the first generator to a new position.

The spacing between these locations has been found to vary greatly with the nature of the soil.

The distribution of galvanic anodes, protecting only isolated corrosive sections,

must be such that two copper-sulphate half-cell electrodes (one placed directly above the pipe, and the other approx. 5 ft away at right angles to the line) indicate a definite current flow from soil to pipe along the section to be protected.

Pipelines can be sectionalized electrically to control current flows of either galvanic or external origin by the insertion of insulating flanges, the line being insulated from the soil for at least 50 pipe diameters.

The insulation of pumping-stations from main pipelines is also necessary and means for carrying this out are described. T. M. B. M.

**372. The " Pluto " Pipeline.** Anon. *Engineering*, 1.6.45, **159**, 425; 8.6.45, **159**, 444; 15.6.45, **159**, 464; 22.6.45, **159**, 483; 29.6.45, **159**, 504.—Operation " Pluto " (Pipelines Under The Ocean) was the undertaking by means of which, in conjunction with the 1000 miles strategic line laid across England, the Allied Forces on the Continent were supplied with petrol.

Originally suggested by Lord Louis Mountbatten to Mr. Lloyd, then Minister of Defence, the first experimental length of " Hais " 2 in pipe was in the form of an extruded lead pipe devised by A. C. Hartley, C.B.E., of the Anglo-Iranian Oil Co.

The first trial length was laid across the Thames by a Post Office cable ship. From the experience gained a second experiment followed in which two lengths of 3 in pipe strong enough to stand a pressure of 1200 lb/sq. in. were laid across the Bristol Channel from Swansea to Watermouth, near Ilfracombe. The tidal conditions in the Bristol Channel were judged to resemble sufficiently those of the English Channel. It provided useful training in the laying of the pipe and operations of all ancillary equipment for the various branches of the services concerned. It was found necessary to make and lay both sizes of pipe under internal pressure, to avoid deformation. Eventually both diameter pipes were laid across the Channel to France.

The " Hamel " pipe developed while these experiments were proceeding was the outcome of a suggestion made by B. J. Ellis, O.B.E., and H. Hammick. It consisted of short solid drawn lengths of steel pipes, butt-welded end to end, and coiled on a drum.

It was proved that 20-ft lengths of 3-in steel pipes could be wound and unwound on a drum having a diameter not less than 30 ft.

In the meantime the Admiralty designed a pipe-laying craft converted from a hopper barge with a drum mounted in trunnions on deck. Later the floating drum was developed capable of carrying a length sufficient to cross the Channel. A factory was also constructed with an output of 10 miles a day and storage facilities of 350 miles of pipe.

In co-ordination with the " Hais " and " Hamel " schemes, shore pumping-stations were provided by the Petroleum Warfare Department. The laying of the pipes was in charge of the Navy. The main bases were at Southampton and Tilbury. Laying of the pipes began soon after D-Day, 4 being laid from the Isle of Wight to a point near Cherbourg and 16 lines from Dungeness to Boulogne. Shore lines operated by the R.A.S.C. extended to Antwerp, Eindhoven, Emmerich, and Frankfurt.

The " Hais " pipe or " cable " was manufactured in the same way, and was indistinguishable from large electric cables. Quayside storage was arranged prior to loading into the ships tanks.

Special handling gear had to be designed and erected at these storage points.

The " Hais " cable was made up of an extruded lead pipe 3·08 in internal diameter with walls 0·195 in thick. It was covered by successive protective layers of 2 thicknesses of paper tape, 1 layer of bitumen-impregnated cotton tape, 4 layers of planished mild steel strip, a serving of gas-tarred jute yarn, armouring of 57 galvanized steel wire, and finally 2 servings of gas-tarred yarn. The finished cable had an outside diameter of 4·488 in, and weighed 67 tons per nautical mile. Designed to stand a pressure of 1500 lb/sq in bursting pressure was found to exceed 3500 lb/sq in.

Internal pressure of 25 lb/sq in was used during armouring, but none during extruding. After extruding, sections were tested to 70 lb/sq in for 25 hours. During laying the cable was filled with water at 200 lb/sq in. A special coupling was evolved to enable jointing to be made without loss of pressure.

Four ships were specially fitted out for laying the " cable," the 2 larger ships having two machines each for picking up and paying out cable, which were arranged fore and aft. These machines were developed, and differed only in minor respects from the normal marine cable gear. The ships were fitted also with roller-type bow and stern

gear to avoid kinking the pipe. Special portable electric hauling gear for handling the cable on board was also provided.

Converted Thames barges fitted with brake and clamping gear were used for landing the shore ends.

Experiments on the Hamel pipe started in 1942. Lengths were hand welded together and not annealed. Coiling tests on a 30-ft-diameter drum were successful.

The tubes used for the pipeline were 3 in bore and 5 S.W.G., and made up from lengths of 20 to 40 ft joined by flash butt-welding. The external and internal flash were removed. The finished pipe failed under hydraulic test at 8100 lb/sq in.

The erection of the production plant at Tilbury started in October 1942, and consisted of welding and handling plant. The 2 parallel sets of conveyors and storage racks had a capacity of 338 sea-miles in 4000-ft lengths, which are joined together in 70-mile lengths for winding on to the drums. The welding flashes were not removed at the 4000-ft joints. 17,120 tons of tube, 845 sea-miles long, was made up at Tilbury in 1338-foot lengths, at an output of 8·3 sea-miles per day.

Winding of the pipe on to the drum was carried out in daylight only. Drums holding 80 miles of pipe were wound in 6 days at the rate of 2½ miles per hour, and a total of 6 drums were made and wound.

The drums which were constructed at Tilbury had barrels 40 ft diameter and 60 ft long, to which were welded flanges 5 ft deep. Conical ends extending 15 ft from each end, on which carried the trunnions prevented the towing bridle from fouling the flanges.

During winding two hinged arms were provided on the jetty which engaged with the trunnions. The drums were revolved by winches.

The pumping plant installed in connection with the scheme consisted of seven 12-stage centrifugal pumps driven by 550-h.p. motors with a capacity of 310,000 gal of petrol per day each at a pressure of 1500 lb/sq in, and 54 reciprocating pumps belt-driven by 60-h.p. diesel engines.

The main pumping-station at Dungeness linked three delivery mains with the 16 cross-Channel pipes starting from that point, and took its power from Hastings to Folkestone. Other pumping-stations were erected at Sandown and Shanklin.

C. D. B.

**373. Reconditioning Storage-Tank Surfaces.** V. M. Coulson. *Oil Gas J.* **5**.1.46, **44** (35), 80.—Proper protection of storage-tank surfaces may be obtained with suitable coating materials when the areas to be protected are efficiently prepared.

Where a protective coating has failed, the coating, rust, and scale must be removed from the vessel surface and the bare metal primed. Simple equipment is required for this cold chemical process, an air compressor as used in paint spraying, two 55-gal steel drums, a 5-cu ft capacity pressure tank operating at 35 p.s.i., spray nozzles and hoses.

22 tanks totalling about 38,500 sq ft, which had been covered with 1 coat of red-lead primer and 4 coats of white paint, were stripped, descaled, derusted, and conditioned by this method by 2 men at a cost of $0·03 per sq ft. 1 gal of paint removing solution was required for 17½ sq ft of surface. Rust- and scale-removing material cleaned 62½ sq ft of metal surface. Paint-stripping materials used were standard products which remove all types of paints except certain baked synthetic finishes. The solution is sprayed over the entire surface of the tank, followed by an air-water rinse, the operation being repeated until surface is clean.

For surface conditioning the vessel is spray-coated with the conditioning solution and allowed to dry before coating with protective material.

The ageing of tank surfaces before painting may soon be superseded by this method.

G. A. C.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**374. Corrosion Problems in the Petroleum Industry. 5 (1) Some Unfamiliar Causes.** A. H. Stuart. *Petroleum*, Dec., 1945. **8** (12), 243.—When any piece of mechanism operating under fatigue stresses, as in that of a repeatedly applied stress ranging from

zero to maximum, and exposed to corrosive conditions such as a damp atmosphere, the corrosion rate increases. An example in the petroleum industry is the case of the sucker-rods employed in pumping mechanisms, and much work has been done on selecting suitable steels. Repeated strains will cause rupture in a protective film, and danger of corrosion is increased.

Corrosive effects are produced by drops of liquid falling on metal from a height. Corrosion occurs between two metal surfaces in contact under pressure, the extent depending on nature of metals and lubricant employed.

Cavitation erosion occurs in pump impellors and other hydraulic equipment. The pitting of the propellers of the Mauretania was studied in 1912; as a result of this and other studies the selection of metals has been found to be important.

This type of corrosion is akin to fatigue corrosion, but another theory postulates electrolytic action. Fretting or contact corrosion is possible in pivot bearings, since, even though load is very light, the stress may reach considerable values. G. A. C.

**375. Corrosion Problems in the Petroleum Industry.** A. H. Stuart. *Petroleum*, Feb., 1946, **9** (2), 42.—Successful application of corrosion-prevention methods is limited to the conditions for which provision is made. Aluminium and its alloys provide an example of the formation of a protective film of the metallic oxide. This film can be thickened by anodizing, the metal being the anode, graphite the cathode, and in one process a 3% solution of chromic acid is the electrolyte.

The process is worked at 40° C, the voltage being raised in easy stages to 50. An alternative process uses sulphuric acid as the electrolyte at about 20° C, with a lead cathode, for about 10 to 50 minutes.

The anodized films provide a good bond for further protectives—for instance, paint.

The Bower–Barff process employs the same principle, chiefly for sanitary fittings.

Parkerizing is the best-known of processes which develop a film of ferrous phosphate on iron or steel, and metal so treated offers a bond for paints.

Sherardizing is a process in which iron, packed in zinc dust, is heated to 250° C, the zinc entering the iron by a form of diffusion.

To guard against pitting of gear wheels, zinc oxide is incorporated in the lubricant and after running some time, the metal surface of the gears is found to contain an appreciable amount of zinc.

Other methods include hot-dipping, as in the making of tin-plate; a tin-pickling process, by which the ferrous article to be descaled is made the cathode, silicon iron the anode, in a hot dilute solution of sulphuric acid containing about 1 gm. of tin sulphate per litre. The profuse evolution of hydrogen helps to remove the scale.

The salt-spray test, designed to examine articles for corrosion-resistance, tests specimens for corrosion in a mist of salt water, is being developed under specified conditions. G. A. C.

**376. Lighting for Oil Refineries.** D. M. Tuck. *Petrol Engr*, Aug., 1945, **16** (12), 113.—The lighting of the services section of a refinery, viz., the offices, laboratories, boiler and power plants, and the various engineering workshops, drawing offices, stores, etc., is discussed.

Illuminating calculations are discussed, and the effect of factors which reduce the lighting power is described. The in-service factor, used in the calculations, is the product of the following: (lamp depreciation × dust and dirt × voltage drop × lamps out (defective and broken) × interception, (of light by machine parts, tools, worker's body, etc.) × atmosphere absorption). This in-service factor when multiplied by the calculated illumination gives the foot-candle value that the maintenance engineer should be able to read with a light meter. The fundamentals of correct and economical lighting are discussed and explained.

In the sections mentioned, practical suggestions for the design of new construction and maintenance of the performance are given, and photographs of certain sections are included. Diagrams show the position of lamps with respect to the kind of work being done, and are annotated with the types and power of the lamps installed, lenses, reflectors, lateral-spread refractors, etc. W. H. C.

**377. Probolog Spots Corrosion, Cracks, Holes in Exchanger Tubes.** Anon. *Oil Gas J.*, 15.12.45, **44** (32), 121.—Shell Development Co., engineers have perfected an instrument

known as the "Probolog," which determines irregularities electrically in exchanger and other non-ferrous tubes, and registers them on a moving paper ribbon. Pits, holes, cracks, thin spots, and other damaged conditions can therefore be logged throughout the tubes length, often before these can be discovered by the naked eye.

The electronic recorder is essentially a Wheatstone bridge, of which the tube under inspection becomes part; in addition to the mechanism for passing the paper strip, a neon light flashes with varying degrees of intensity as irregularities in the tube wall are passed. The instrument is available for sale to the industry. T. M. B. M.

**378. Mixing Liquids in Shallow Tanks Aided by Design Analysis.** E. S. Bissel, H. J. Everett, and J. H. Rushton. *Chem. Met. Eng.*, 1946, **53** (1), 118.—The problem of mixing is discussed in relation to the proportions of the tank; number and size of tanks; shape of tank bottoms and corners; rate of liquid draw-off; type, size, and number of impellers, and variable speed of impellers. It is recommended that: (1) the depth of liquid over the impeller to prevent vortexing should be not less than $1\frac{1}{2}$ times the diameter of the propeller; (2) the maximum ratio of tank diameter to liquid depth should vary proportionately from 2 : 1 for a liquid depth of 1 ft to 7 : 1 for a liquid depth of 15–20 ft; (3) no tank should be considered for suspension of solids where the slurry is to be drawn off, unless the depth of liquid is at least equal to the diameter of the tank and preferably $1\frac{1}{2}$–2 times the diameter; (4) tank bottoms should be dished or conical; (5) the propeller diameter should be $\frac{1}{3}$ to $\frac{1}{4}$ of the tank diameter, or of the diameter of the cone at the position of the propeller. L. B.

**379. Chemical Requirements of the Petroleum Refining Industry.** Anon. *Chem. Met. Eng.*, 1946, **53** (1), 139.—The enormous quantities of chemicals consumed in petroleum refineries are discussed. Figures which are tabulated show that the major usages are of $H_2SO_4$, clay, NaOH, and tetraethyl lead. The functions of the large variety of the chemicals in the industry are reviewed. L. B.

**380. Mexico Slated to have One of World's Largest Refineries.** C. Vinson. *Oil Gas J.*, 5.1.46, **44** (35), 42.—The Atzcapotzalco refinery near Mexico City has been expanded and it is now one of the largest modern refineries in the world, with a daily capacity of 40,000 brl of crude. Six new units have been built at this refinery, and a 65,000-brl crude-stabilization and 70,000,000 cu. ft. daily capacity gas-absorption plants erected at Poza Rica, and improvements made to pipelines, at an expenditure of $20,000,000. Mexican engineers are being trained in U.S. refineries for operation of these plants.

$6,000,000 is to be spent on a 25,000-brl refinery at Salamanca, Guanajuato, and a like amount on a 282 mile, 12-in pipeline from Poza Rica. The Salamanca refinery is to be partly built from plants at Tampico which are being dismantled. Plant expected to be in operation by 1947.

The cracking unit at Atzcapotzalco will handle 11,500 brl of residue from crude. The power-plant will have two generators of 5000 kva. each. Tank storage has been extended to 2,000,000 brl. Electrical pumps are being installed at the 6 stations along the Poza Rica—Mexico City pipeline.

The total Pemex refinery capacity will exceed 160,00 brl day. G. A. C.

**381. Haifa Refinery Played Important Part in Supporting Allied Operations in Mediterranean Theatre.** E. Aschner. *World Petrol.*, Dec., 1945, **16** (13), 44.—Haifa refinery, second largest in Middle East, originally designed for capacity of 2,000,000 tons/year, has been considerably expanded, and had an input of 3,292,000 tons in 1944, producing butane, narrow-cut naphthas, gasoline, kerosine, gas oil, diesel and fuel oils, and asphalt. Refinery production began Nov. 1939, one year ahead of schedule, employing 1 crude topping unit and 2 treating plants. Additional units for crude topping and asphalt production were erected during the war, and the cracking sections of 2 crude units not in service were converted into additional crude distillation units.

Total refinery throughput during the war was 12,000,000 tons, and about 6,000,000 tons of fuel oil and 2,500,000 tons of benzine produced went to the fighting services, a valuable contribution to the war in Africa and the Mediterranean. Products were also supplied to Palestine. G. A. C.

## Distillation.

**382. Tray Details—Bubble Caps. The Refiner's Notebook.** No. 54. W. L. Nelson. *Oil Gas J.*, 11.8.45, **44** (14), 125.—Many designs of bubble caps are in use, but usually

they are of bell or cup shape, as shown by a sketch of a cast-iron bubble cap and yoked upriser held together by a bolt. They are designed so that a minimum pressure drop exists from plate to plate. To provide this the area of the annular space should be equal to the area of the vapour uptake, chimney, or riser. Therefore the outer diameter of the riser should be about 65% and 61% of the diameter of the cast-iron cap or steel cap respectively, and the space between the top of the bell and top of the riser should be greater than one-fourth of the inside diameter of the riser. Total area of the slots and the area of the open space between the cap bottom and the tray should be greater than the area of the vapour riser. A tabulation shows details of commercial bubble caps from 2½ in to 6 in diameter in terms of slot area; vapour uptake area, uptake area over column area. The pressure drop per plate in pounds per square inch may be approximated by: $P = k.s.u.^2 + 0{\cdot}022\ C$, in which $k$ is constant ranging from 0·01 to 0·015, $s$ is specific gravity, $u$ is velocity through riser in feet per second and C is the height in inches of liquid over the centre of the slots. W. H. C.

**383. Refiner's Notebook. Bringing a Tower on Stream.** *Oil Gas J.*, 22.9.45, **44** (20), 325.—Water is present in a tower that has been off stream because steam is normally used to clear it of oil vapour. The operations necessary to allow normal operations to recommence are described, and these are shown diagrammatically with a sketch of a typical fractionation set-up. T. M. B. M.

## Absorption and Adsorption.

**384. Application of Diethylene Glycol-Water Solution for Dehydration of Natural Gas.** N. K. Senatoroff. *Oil Gas J.*, 15.12.45, **44** (32), 98.—Diethylene glycol has proved to be a very satisfactory substitute for the calcium chloride previously employed for dehydration of natural gas, and has the advantage of being less corrosive than the latter.

The paper presents some of the process engineers' basic computations pertaining to the design of suitable equipment.

The application of diethylene glycol solution to dehydration of natural gas at operating pressures in excess of 1000 lb/sq in was recently tried on the Pacific coast in connexion with the Goleta-Ventura natural gas transmission line, but rigorous engineering design of absorption equipment was impossible owing to complete lack of data on the properties of glycol solution at this high pressure. Pilot-plant experiments were impossible owing to shortage of time. It was therefore decided to limit design computations to purely theoretical studies of the effect of increased operating pressure on the important phases of the absorption process, taking as a basis some data obtained from a similar plant working at 400 lb/sq in.

Examples of the calculations are given, with detailed information as to the properties of ethylene glycol in solution and the saturated water-vapour content of natural gas.

Drawings of the absorbers and bubble caps employed are included, and consideration given to factors such as absorber diameter, effect of pressure on absorption rate, plate spacing, and number of plates used.

A bibliography is included. T. M. B. M.

## Cracking.

**385. Thermal Cracking of Petroleum.** H. C. Sung, G. G. Brown, and R. R. White. *Industr. Engng. Chem.*, **37** (12), 1153–1161.—Using apparatus and procedure giving results within the range of accuracy required for the design and operation of thermal cracking units, experimental data on the thermal cracking of industrial combined-feed and virgin close-cut fractions have been obtained. The effect of time, temperature, pressure, and type of charging stock on the distribution and type of product, and on the rates of the reactions involved, has been evaluated from these results. Specific rates of reaction for the decomposition of the close-cut fractions for the production of gas and light distillate oils of certain end-points, have been calculated. The specific polymerization rates have been determined, as well as qualitative information on the rate of formation of coke. A. W.

**386. Olefin Production by Thermal Cracking of *iso*Butane.** P. M. Arnold. *Oil Gas J.*, 7.7.45, **44** (9), 87.—When *iso*butane is thermally cracked, about 60% is dehydrogenated,

forming *iso*butylene and hydrogen, and 40% is demethanized, giving propylene and methane. Secondary reactions also occur; (1) in which the products are further cracked giving hydrogen, methane ethylene, tars and coke to a limited extent; and (2) polymerization of the olefins, which is more critical as high-molecular-weight compounds are formed, which in turn break down to tars and coke. As polymerization is affected by pressure and the concentration of the olefins, the operation must be conducted at low pressures to limit the extent of cracking. The *iso*butane used for olefin production should be pure, but 10% or less of *n*-butane and higher hydrocarbons will not seriously affect the results. Pentanes and higher hydrocarbons should be less than 1–2%, as these compounds more easily crack, to products which tend to degrade to tars and coke. Sulphur should be removed. Because of polymerization, butylenes should be limited to 2%.

The original Phillips' plant is described; it was designed to process 75,000 gal/day. Yield data and pilot-plant work indicated that 20–30% *iso*butane cracked per pass through the coil would give the best results.

The reaction temperature chosen was about 1200° F and heat input was limited to about 7000 and 6000 B.Th.U. per hour/per sq ft of outside tube area, respectively, for convection and radiant tubes. The *iso*butane feed was vaporized by exchange of heat from the reaction products. The furnace coil outlet is set at 30 p.s.i. to avoid the use of blowers, and the pressure drop was limited to 100 p.s.i. Modifications and arrangements to the plant are described by which means the capacity was increased to 125,000 gal/day. To avoid excessive drop through the tubes the serial-flow furnace tubes were rearranged for flow in 2 streams, and the final 7 tubes in each radiant section were replaced by tubes ½ in larger than the preceding ones of 4-in outside diameter with ¼-in walls. Larger burners were installed. A flow controller regulates the feed-stream, and the reaction is regulated by varying the feed supply by the use of automatic gas-density controllers on the furnace outlet lines. The "Cycloil" gas-cleaner used to remove fine coke particles is described. In the 2 flow-furnace coils the temperature was increased to 1350° F, with a pressure drop of 71 p.s.i. through the coils, compared with 100 p.spi. for half the flow rate. One coil is decoked by steam and air, whilst the other continues in operation. Test data are given for different flow rates. The yield of *iso*butylene decreases as the percentage conversion and flow rate increase. The mechanism by which coke builds up in crevices and ruptures the tubes is described; for this reason the tube welds must be perfect, and conventional return bend fittings avoided. A properly designed unit can be kept on stream 95% of the time.

W. H. C.

**387. T.C.C. Catalytic Cracking Process for Motor Gasoline Production.** R. H. Newton, G. S. Dunham and T. P. Simpson. *Petrol Engr*, Oct. 1945, **17** (1), 210.—In the Houdry and T.C.C. catalytic cracking processes a stream of vaporized oil is passed through a bed of cracking catalyst consisting of pellets of activated natural clay or of the synthetic silica-alumina type.

The products are light gases, a B-B fraction mainly *iso*butane and butylene, a gasoline cut consisting of *iso*paraffins, aromatics, olefins, and naphthenes, a gas oil richer in aromatics than the virgin gas oil.

Following the commercialization of the Houdry fixed-bed method, 34 units employing the moving-catalyst principle are successfully operating in the T.C.C. cracked process for production of aviation gasoline.

The T.C.C. unit consists of a reactor and a regenerator. In the reactor the oil passes through a bed of catalyst from 8 to 35 ft in depth, which is moving downwards at a uniform rate. At the bottom the catalyst is removed and transported to the regenerator, where it is passed downwards through a series of burning and cooling zones, the counter-flow principle being employed.

Careful laboratory studies in establishing the process were made. For example, catalyst particle size eventually chosen was 0·1 to 0·2 in; elevators of about 200-ft lift were found necessary; and a catalyst bed depth at least 1·5 times the spacing of the distributor holes are required above the flow-control plate to ensure vertical movement.

Alternate burning and cooling zones in the regeneration phase ensure initiation of combustion, limit maximum temperature to 1150° F, and prevent too rapid deterioration of catalyst.

Rate of combustion of the carbon deposit on catalyst pellets was found to depend

on limits of inlet and outlet temperature for each zone. Latest kilns have from 7 to 10 burning sections.

It is important to isolate the oil system from the air by means of pressure seals of inert gas; and formula are developed to calculate the required pressure drop.

Heat transfer from gas to pellet catalyst has been studied, and found to be extremely rapid, but precise mathematical use of the data is difficult. The coefficient for heat transfer from gas to catalyst was found to vary from 0·003 to 0·013 cal/sec/°C/cc. A typical heat balance is tabulated.

The cracking plant is of conventional and simple design. The reactor vessel has unique distribution of oil vapours, sealing, catalyst-flow control, and purge system. Flue gas provides the seal, and inverted relatively narrow channels connected to an inlet duct passing along the diameter distribute the oil. The catalyst passes over the feed-grid, and is coated with a deposit of higher-boiling constituents of oil, some already coked.

Purging is accomplished in 2 steps in a relatively short time, and equal distribution of the purge steam to each of the 400 odd holes is ensured.

The temperature conditions in the reactor are such that a simple cylindrical steel vessel can be used, and insulation placed outside the steel. For corrosive stocks the reactor is lined with the proper alloy steel.

The kiln is of improved and simplified design, angle packing has been eliminated, and salt-cooling system replaced with direct steam-generating coils. Distribution and control of catalyst flow are as arranged in the reactor. No sealing of top of kiln is required. Two separate air systems are provided, one can be used for cold, the other for hot air.

The elevator links are of low-alloy steel, designed to operate at temperatures up to 900° F. The upper sprockets and head-shafts are also designed for high-temperature operation. The sprocket teeth are lubricated by a layer of fine graphite, main bearings are water-cooled and oil lubricated.

Thus the T.C.C. reactor system is flexible, with a wide variety of oil and catalyst contact times, and regeneration can be controlled in a separate vessel. G. A. C.

**388. New Pellet Dryer for T.C.C. Catalyst Offers Diverse Post-war Uses.** J. W. Payne and C. H. Lechthaler. *Chem. Met. Eng.*, 1945, **52** (12), 105.—An efficient pellet dryer for T.C.C. catalyst, developed by the Socony-Vacuum Oil Co., is described. Successful pilot plant studies enabled a large-scale dryer to be constructed in the minimum time. The unit is described with illustrations, and a graph is given showing the relationship between pressure drop, particle size, and air-flow rate through granular materials. It is considered that the apparatus may be applied to the drying of grain, dehydrating foodstuffs, and drying granular materials for chemical and related industries.

L. B.

**389. The Design and Operating Features of Houdry Fixed Bed Catalyst Cracking Units.** R. H. Newton and H. A. Shimp. *Petrol Engr*, Oct. 1945, **17** (1), 240.—In the fixed-bed plant the catalyst is contained in specially designed cases. Several gas-streams are passed through each bed in sequence, obtaining the steps of cracking, purging, regeneration, and purging. By the use of a number of catalyst cases the flow of all major streams is continuous.

This process demands that heat is supplied when and where required and is removed during regeneration, the catalyst must be purged, and excessive build-up of catalyst deposit prevented.

A yield of gasoline obtained at about 4% wt of carbon deposit is near economic maximum, and units should be designed to handle about 4 to 5% of the charging stock as carbonaceous deposit to be removed from catalyst. Conversion at space rates of 1 liquid vol of oil per vol of catalyst per hour, and higher, makes it necessary to burn 7·8 lb carbon per hr for each 100 lb catalyst on stream. Combination with the heat capacity of the catalyst and heat-transfer elements gave a carbon burning rate of 1·1% wt of the catalyst in 10 minutes, thus ensuring no damage to the catalyst.

To avoid catalyst poisoning, the design allowed for a carbon deposit of 1·1% wt, and a regeneration period of 10 minutes.

A second type of cycle, involving 4 catalyst cases, employs on-stream periods as short as 7½ min.

Two general types of cycle timer are used, differing principally in the type of con-

tactor. Motor-operated forged steel-body gate valves suitable for frequent operation at about 850° F are employed. Steam is used to seal the gate and prevent leakage.

The catalyst cases contains cooling, oil, and air tubes; outlet and collecting ports are arranged so that the vapour path is about 30 in, thus allowing the use of the limiting orifice principle for ensuring good flow distribution.

The bottom of the case is complicated, arrangements for salt flow in and out and air introduction having to be made. Analysis of the factors affecting heat transfers are difficult, but cooling fins are so designed that an average overall heat transfer coefficient of 6·4 B.T.U./hr/sq ft/°F is obtained. This involves conduction and radiation from pellets to fins and convection between gas and fins. Temperature control at the border of the tube pattern has been arranged, and cooling coils are provided to give further protection against damage to the case shell.

A molten eutectic mixture of $KNO_3$ and $NaNO_3$ is used to control temperatures in the catalyst bed, and the salt circulating through the case is maintained under a vacuum to prevent oxidation and minimize hazards.

Air is excluded from storage tanks by a steam blanket.

The salt system also provides a source of high-temperature heating fluid, producing 450 lb/sq in steam, etc.

An axial type turbo-compressor unit is used for power recovery, the average net electrical power output being 120 kw.

The units produce 40–48% of gasoline with a clear octane number of 80 C.F.R. Motor method.

In the Houdry process the equipment permits catalyst temperatures from 650° to 875° F, and pressures from 5 in mercury absolute to over 200 lb/sq in, and the wide choice of operating cycle permits almost any degree of severity required.

G. A. C.

## Isomerization.

**390. 60 Per Cent Yield in Liquid-Phase Isomerization of Pentane.** L. S. Galstaun. *Oil Gas J.*, 5.1.46, **45** (35), 56.—At Avon, California, a liquid phase pentane isomerization plant of the Shell type has been in operation since 1944. The plant is essentially similar to the liquid phase butane isomerizers using antimony trichloride as a catalyst carrier. The catalyst is anhydrous aluminum chloride, together with 5 mol % of anhydrous hydrogen chloride. Some mechanical changes in design and operating technique have been made.

Normal pentane, after drying, is fed to the preheater, thence to the bottom of the catalyst scrubber, where antimony trichloride and free aluminium chloride are countercurrently extracted from reject catalyst stream entering at top of column. The pentane stream flows to the contactor, where it is subjected to isomerization conditions after injection of HCl and antimony trichloride. Reaction temperature is 200° F, pressure 300 p.s.i. Means are provided by which recycle streams are separated and returned to the process.

In the catalyst removal column, mixed pentanes, hydrogen, and HCl are distilled off as overheads, while antimony trichloride containing a small proportion of aluminium chloride is separated as bottoms. The catalyst column is equipped with a reboiler containing a surge-chamber. The overhead portion is partly condensed, and condensate used as reflux. The bulk of gas is recycled to the contactor; from the remainder hydrogen and light hydrocarbons are removed, HCl and heavier hydrocarbons being retained. In the HCl stripper the accumulator liquid yields HCl overhead and isomerized plant product as bottoms, which latter is cooled and caustic washed. Chemical analyses constitute process-controls, important variables being temperature of contactor, concentration of aluminium chloride in catalyst, concentration of HCl, volume of hydrogen recycled to contactor, and concentration of inert hydrocarbon–aluminium complex in the catalyst.

No corrosion protection is required in vessels and lines in pentane service; carbon steel is used elsewhere except where turbulent conditions exist or no corrosion is tolerable—an example being the contactor, where the steel is nickel clad.

Special precautions in handling the catalyst are necessary. All catalyst lines and vessels must be kept heated, since the catalyst melts above normal atmospheric temperature.

Experience has shown that the process is sound, but control more critical for pentane than for butane. G. A. C.

## Special Processes.

**391. German Plants Extract Gasoline from Coal.** L. C. Halfpenny. *Petrol. Engr*, Aug. 1945, **16** (12), 188.—A brief description is given of two plants for producing and processing brown coal which are situated at Böhlen and Espenhain near Leipzig, Saxony. Thirteen photographs are shown of the field and plant. The lignite appears to be of Miocene age, is a mealy peaty substance, containing about 53% water, and is found in beds 2 to 20 ft thick, interspersed by silt and overlain by about 50 ft of recent glacial deposits, sands, and gravels. The mining and transport to bunkers at the top of a four-storey building are described. From the bunkers, half is transported by belt conveyors to power plants for drying and burning to provide electric power, the other half is similarly transported to the pulverizing plant to be pounded through 1-in mesh sieves and then passed to the drying-ovens, in which the water content is reduced to 13%. This material is then compressed into bricks about 4" × 6 in, and the briquettes transported to 30 drying ovens each of 300 ton/day capacity, and by a continuous passage taking 24 hours, become bone dry. They are then burned at 600° C in an absence of oxygen and produce coke, gases, and tars ("Teerantar").

The coke is burned for auxiliary heat and power. Some of the gas is cooled at 300 atm from 280° to 25° C at this stage. As some of the tar is in the form of collodial particles suspended in the remainder of the gas, the mixture is separated at 110° C by 50–60,000 v. This gas is then cooled from 110° C to 25° C at 300 atm. This condenses most of the liquids which are added to the tar. All the gas is then passed to absorbers which remove the last 5% of the benzine. The dry gas is desulphurized with an alkaline solution in a vacuum. The sulphur removed is a most important by-product. The purified gas is marketed in nearby towns. The moisture from the ovens is extracted for phenols, and the water is used for cooling. Two-thirds of the tar is piped to the Böhlen works, 3 miles away. The remainder is converted at the producing centre. The Espanhain works (built in 1938–39, at a cost of $100,000,000) can deal with 9,000-metric tons/day of lignite, and yield about 11% of benzine (350,000 gal)—*i.e.*, about 5% of the mined lignite. The tar is subjected to a hydrogenation and selective distillation process, the end-products being benzine (about 60–65 octane number), diesel oil, and paraffin. The benzine is blended with benzol to give a motor fuel of 75 octane value. The diesel oil is used without further treatment, the paraffin is used for cracking operations. W. H. C.

**392. The Process of Sulphation.** S. Glicher. *Petroleum*, Dec. 1945, **8** (12), 232.—The first general procedure in the sulphation of fatty oils is to add slowly 98% sulphuric acid, preferably as a spray, whilst stirring, and then to wash the sulphate produced.

Oils of the vegetable group, especially the non-drying type such as castor peanut and almond oils, are easiest to sulphate.

Practical tests should be made during sulphation, washing, and neutralization. With Turkey red oil, the turbidity of the solution is a criterion in the first two processes; whilst neutralization should take place in the cold and stop when the product clarifies.

Fish oils such as cod and whale are more difficult to sulphate. The presence of water is harmful; 20 to 23% of sulphuric acid will cause a high degree of sulphation; and degree of mobility of product is important. Washing and neutralization are effected, cold, and carefully controlled by solubility tests.

Terrestrial animal oils—for example, neat's foot and lard oils—have to be carefully sulphated, the temperature not being allowed to rise above 30° C, and solubility tests made as with the other groups. G. A. C

# PRODUCTS.

## Chemistry and Physics.

**393. The Depolarization of Light Scattered from Polymer Solutions.** P. Doty and H. S. Kaufman. *Journ. Phys. Chem.*, Nov. 1945, **49** (6), 583–594.—The theory of depolarization of scattered light is developed with particular reference to the study of polymer

molecules in solution. A simple apparatus, based on the Cornu method, is described. This permits the measurement of the depolarization of the transversely scattered light, using unpolarized and vertically and horizontally polarized incident light. Measurements on fractions of cellulose acetate, polyvinyl chloride, and polystyrene as a function of molecular weight, concentration, and solvent are reported. The data are interpreted in terms of the changes in anisotropy and size as a function of the above-mentioned variables. A. H. N.

**394. Correlation of Viscosities of Liquids with Temperature.** M. S. Telang. *J. Phys. Chem.*, 1945, **49**, 579.—The variation with temperature of viscosities of non-associated liquids can be represented by the empirical equation :—

$$\frac{1}{\eta} = \frac{m}{(1 - T_r)^{\frac{1}{3}}} - k$$

where $\eta$ = viscosity in centipoises at $T°K$, $T_r$ = reduced temperature = $T$/critical temperature, and $m$ and $k$ are constants. Associated liquids, like water and alcohol, show deviations at lower temperatures. For 7 other organic liquids the maximum deviation from the equation is about 1%. H. C. E.

**395. The Methods of Specifying the Properties of Viscoelastic Materials.** T. Alfrey and P. Doty. *J. Appl. Phys.*, 1945, **16** (11), 700–713.—Seven methods (Voigt model, Maxwell model, operator equation, mechanical impedence function, creep curve, relaxation curve, and dynamic modulus function) of specifying viscoelastic behaviour are discussed. A number of exact relations between these methods of specification are worked out in detail. The majority of these relations are simple enough to be of practical value, although a few are too cumbersome. Approximate relationships between the creep curve, the relaxation curve, Maxwell model, and Voigt model are discussed ; and numerical examples show the magnitude of errors introduced by the approximation to be small even in quite unfavourable cases. A consideration of the practical utility and physical meaning of the various methods of specification distinguishes between (1) those of general descriptive value and those of direct experimental value and (2) those useful in a phenomenological study of mechanical behaviour and those more suited to a formulation of molecular theory. A summary of the present molecular theories is presented, together with their interpretation in terms of the Voigt and Maxwell specifications. A. H. N.

**396. Polymerization of Alpha-Methylstyrene.** A. B. Hersberger, J. C. Reid, and R. G. Heiligmann. *Industr. Engng. Chem.*, 1945, **37** (11), 1073–1078.—α-Methylstyrene has been homopolymerized by solutions of Friedel-Crafts catalysts in organic solvents at temperatures as low as −130° C to molecular weights as high as 84,000. The highly-polymerized product includes a wide range of molecular weights as shown by distribution curves based on fractional precipitation. This polymer is not distorted in boiling water, and has a higher fusion point than polystyrene, but is inferior in strength to the latter.

A copolymer of *iso*butylene and α-methylstyrene, which can be formed into thin, strong, flexible sheets, has been made by the same polymerization technique. The emulsion copolymerization of butadiene and α-methylstyrene yields an elastomer comparable to that now obtained from butadiene and styrene ; the optimum ratio of butadiene to α-methylstyrene contains a greater proportion of butadiene than is used with styrene. In this copolymerization, α-methylstyrene has advantages of stability and ease of handling when compared to styrene. A. W.

**397. Catalyst Cracking of Pure Hydrocarbons.** B. S. Greensfelder, H. H. Vige, and E. M. Good. *Industr. Engng. Chem.*, 1945, **37** (12), 1168–1176.—The cracking of 22 aromatic hydrocarbons over a silica-zirconia-alumina catalyst is reported. A wide range of behaviour is observed from nearly inert compounds like toluene or biphenyl, to highly reactive ones such as aromatics with substituent alkyl or *cyclo*alkyl groups containing 3 or more carbon atoms, for which the removal of the whole substituent group is the chief cracking reaction. Results from catalytic of the various hydrocarbon classes are reviewed. The stability of compounds of a given carbon number in processing over the cracking catalyst, increases in the order : olefines, aromatics, with $C_3$ or larger substituent groups, naphthenes, polymethyl aromatics, paraffins, and unsubstituted aromatics. This order differs substantially from that found in thermal cracking. A. W.

## Analysis and Testing.

**398. Determination of Water Content in Oils.** M. M. Acker and H. A. Frediani. *Industr. Engng. Chem. Anal.*, 1945, **17** (12), 793–794.—A technique is presented for the determination of moisture in insulating and lubricating oils, using the Karl Fischer reagent. A. W.

**399. Lamp Method for Determination of Hydrogen in Liquid Organic Compounds.** S. G. Hindin and A. V. Grosse. *Industr. Engng. Chem. Anal.*, 1945, **17** (12), 767–769.—Detailed experimental procedure is given for the determination of hydrogen in liquid organic compounds by a lamp method. The analysis of a series of pure compounds, ranging in volatility from diethyl ether to cetane, and containing from 10 to 16% hydrogen, indicated an average accuracy of 0·03% hydrogen and an average precision of 0·02% hydrogen. Analysis of known mixtures gave results of similar reliability. The technique possesses several advantages over the Leibig-type combustion; the modifications for the analyses of aromatic and unsaturated hydrocarbons have yet to be described. A. W.

**400. Determination of Butadiene Dimer in Recycle Styrene.** H. A. Laitinen, A. S. O'Brien, and S. Wawzonek. *Industr. Engng. Chem. Anal.*, 1945, **17** (12), 769–772.—Butadiene dimer (4-vinyl-1-*cyclo*hexene) is determined in recycle styrene by the iodine chloride method after first quantitatively polymerizing the styrene present, using sodium as catalyst and dioxan as solvent. The method is sensitive to 0·2% vinyl *cyclo*hexene and is accurate to about ±0·2% (absolute) over a range 1 to 20% vinyl *cyclo*hexene. A. W.

**401. Determination of the Purity of Hydrocarbons by Measurement of Freezing Points.** A. R. Glasgow, Jr., A. J. Streiff and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, Nov. 1945, **35** (5), 355.—An improved and simplified procedure for determining the freezing points of hydrocarbons from time-temperature freezing and melting curves, and for calculating the purity when the freezing point for zero impurity is: (*a*) known; and (*b*) not previously known, is described as well as the procedure for determining the cryoscopic constant. Full details as to apparatus employed is given. Reproducibility in freezing point determinations is considered to be 0·01–0·02° C. T. M. B. M.

**402. The Rapid Determination of Tar and Bitumen in Road Material.** E. H. Green and E. A. Cox. *J. Soc. Chem. Ind.*, 1946, **65**, 1.—A rapid method, suitable for routine plant control, is described for the determination of bitumen or tar content of bituminous surfacing materials. Soluble binder is extracted from the mixture by shaking with methylene chloride and filtering. The solvent is evaporated from an aliquot portion of the filtrate, under reduced pressure. Time for a complete analysis, according to type of mix, is ½–1½ hours. Results agree well with those of methods previously employed, the latter being reviewed. F. S. A.

## Crude Oils.

**403. Petroleum in Kansu Province, China.** H. J. Gavin. *Petrol. Engr*, Oct. 1945, **17** (1), 181.—The first field of considerable importance in China, the Laochunmiao, was established in 1941 in the Kansu "Corridor" at about 8000 ft above sea level.

Despite great difficulties, particularly in transport, development has progressed steadily as experience was gained. By March 1945 all producing wells were flowing under control through flow beans.

Wells were drilled by the rotary method, using diesel-powered equipment. The crude oil is of intermediate base, approximately 32·5° A.P.I., 50° F. pour point and 0·15% sulphur. Gas is separated in brick tanks, and the high pour point of the oil coupled with low atmospheric temperature necessitate steam heating of tanks and lines.

The crude oil is refined in a pipe-still unit; many of the pumps, shell stills, and boilers are of Chinese manufacture.

Straight gasoline (21% yield), kerosine, gas oil, and wax are produced, but residual fuel oil and heavier fractions are discarded to waste. Very good facilities for the welfare of the employees have been established.

The Chinese engineers have ingeniously improvised; for example, smoke-stacks were made from oil-drums, insulated inside when necessary; copper and brass coins were used to cast globe valves.

Except for bulk paraffin and finished candles all products are shipped in drums by trucks or animal-drawn carts. Truck transportation to Chunking is augmented by large rafts, buoyed by some 300 goatskins, on which drums of gasoline are floated down the Chialing River.

The production of the Laochunmiao oilfield is still small, but was of great importance during the war: in the northern regions the gasoline from this field has been of considerable value, as also were the kerosine and candles.

It is likely that this field and others yet to be discovered will be of prime importance in China's future economy. G. A. C.

## Gas.

**404. Synthetic Ammonia Produced from Natural Gas.** J. A. Lee. *Chem. Met. Eng.*, 1945, **52** (12), 94.—The plant operated by Mathieson Alkali Works at Lake Charles, La., is described. Natural gas arrives at the plant by pipeline at a pressure of 300 p.s.i. The pressure is reduced to 50–75 p.s.i., and the gas purified from sulphur by passage through towers containing bauxite. The issuing material is then mixed with steam and fed through a furnace packed with a suitable catalyst, in which decomposition to $H_2$, CO, and $CO_2$ is effected at 1300° F. The mixture still contains unreacted hydrocarbon, and is next burnt in a " combustion furnace " with an amount of air calculated to yield the correct $H_2/N_2$ ratio in the feed to the ammonia plant. The product leaving the furnace at 2000° F is cooled by a water-spray quench to 800° F, and, at this point, consists of 40% $H_2$, 11% CO, 4% $CO_2$, and 28% steam. In the next stage the CO is converted to $CO_2$ catalytically. The latter is extracted by means of monoethanolamine at 200 p.s.i. and 100° F, and residual CO by a cupric/cuprous formate solution at 2100 p.s.i. The pumped gas is then compressed to 4000 p.s.i., passed into the ammonia converters, where promoted iron catalysts effect the synthesis at 923° F. The reaction product exchanges heat with incoming recycle gas, and leaves the converters at 375° F, containing 16% ammonia. The latter is condensed by further cooling and chilling, and separated. Recycle gas carrying some 2½% $NH_3$ is returned to the ammonia converters. L. B.

## Engine Fuels.

**405. New Safety 100-Octane Aviation Fuel.** J. H. Kunkel. *Petrol Engr*, Aug. 1945, **16** (12), 172.—The activities of the Standard Oil Development Co. in the production of a safety 100-octane aviation fuel are reviewed from 1932. The new fuel is for use in ignition-ignited fuel-injection aircraft engines, and is briefly described as having a flash point of 105° F., and as having all the power characteristics of the ordinary 100-octane aviation gasoline. It is produced by a hydrogenation process. A practical demonstration of its safety is described and illustrated, which shows its slow evaporation compared to 100-octane avaition gasoline, and their respective inflammabilities. W. H. C.

## Lubricants.

**406. Anomalous Viscosity of Lubricants at Low Temperatures.** P. A. Rebinder, N.A., Boguslavskaya, and V. B. Mokievskii. *Petroleum*, Dec. 1945, **8** (12), 233.—Study of viscosity at low temperatures is complicated by difficulty of interpreting the results obtained, the viscosity values being made indefinite due to formation of colloidal and crystalline structures.

The process of flow in semi-solid lubricants consists of a succession of fissures followed by a renewal of the structure, thus leading to a infinite number of individual mechanisms and behaviours.

The static yield value corresponds to the pressure required to transfer from slow Newtonian flow to structural flow. The value for this can be tens of thousands of times more than that for structural flow.

The yield value characterizes properties such as setting point, flow over surfaces, creep, etc.

The limiting pressure is constant within extremely wide limits, and a table shows measurement of the yield value θ in G/cm² in capillaries of varying width, both the capillary-tube method and that based on the longitudinal displacement of a cylinder giving satisfactory results. G. A. C.

**407. Lubrication Vade Mecum Addendum (2).** E. W. Steinitz. *Petroleum*, Feb. 1946, **9** (2), 31.—In this addendum to the Lubrication Vade Mecum notes are given on lubricants for general technical equipment comprising air compressors, ball-bearings, gear boxes, worm gears, and vacuum pumps; for rotary coal driers, ore-roasting kilns and winding engines in mining and related industries, and on calendars, conical mills, and other machines used in the pulp, paper, and stationery manufacture and printing. G. A. C.

## Asphalt, Bitumen and Tar.

**408. Bitumen and the Bitumen Industry with Special Reference to Asphaltic Bitumen. 5 (2). Industrial Applications of Asphaltic Bitumen.** J. S. Jackson. *Petroleum*, Dec. 1945, **8** (12), 234.—Outside coatings have to withstand wear and tear of handling and laying, formulas based on blown bitumen and fibrous fillers being successful. Pipes are primed with bitumen before coating, and for maximum protection finally wrapped with bitumen—impregnated coir fabric after thickness of the coating has been measured by an apparatus designed for the purpose.

Bitumen is extensively used for lining and water-proofing tanks, being strongly adhesive to concrete, brick, metal, or wood; and for many hydraulic works, such as canal banks, dams, and reservoirs.

Bituminous joint-filling compounds, containing a fibrous filler to increase shock-resistance, are used for a variety of purposes. Laboratory tests designed to test the accommodation of the composition to movements of concrete masses due to changes in temperature or ground subsidence, and its adhesivity to maintain a waterproof joint, are applied.

Such joints are of special importance in construction of protective revetments on coasts, canals, and reservoirs.

Resistance to flow on sloping surfaces is important; two types of mixtures, one containing a high, the other a low percentage of bitumen have been evolved.

The Shelperm process is one in which a fine emulsion is pumped through injection tubes into suitable porous sands, where it breaks up on reaching the desired location, or predetermined time, due to the addition of suitable coagulants.

It is essential that particle size of the dispersed bitumen phase is adjusted to the porosity depending on required depth of penetration.

The process was used in connection with the extension to the Assiut barrage on the Nile, practically complete impermeability of the subsoil being achieved.

Bitumen is also used in the manufacture of brattice-cloth, dampcoursing, special lubricants, adhesive and numerous minor applications. G. A. C.

## Special Hydrocarbon Products.

**409. Petroleum to Supply all Butadiene Next Year.** H. D. Ralph. *Oil Gas J.*, 15.2.45, **44** (32), 70.—The use of alcohol for synthetic rubber production has been discontinued in America from the end of 1945, and all butadiene scheduled for 1946 rubber production will be produced from petroleum.

Production of 413,000 tons of butadiene is called for in 1946, which is expected to yield 600,000 tons of synthetic rubber. This amount, together with the 300,000 tons of natural crude rubber which will be imported, is expected to meet all demands, although butadiene manufacture can be increased if necessary. The contribution to be made by each of the producing petroleum butadiene plants is given.

The 11 alcohol butadiene plants to be closed down (which produced 360,000 tons of butadiene in 1944) are also listed, but it is thought that they will be retained by the Government in standby condition. Butadiene from alcohol cost 40 c/lb compared with that of 8–10 c/lb for petroleum.

Three petroleum butadiene plants are also being closed down; these all used the naphtha-cracking process, which is more expensive than the other petroleum butadiene

processes in use. All the present copolymer plants will remain in operation, and are expected to operate on about 580,000 tons which will just balance the butadiene output of the petroleum process plants.

Although the cost of producing synthetic rubber on a peace-time basis has not yet been determined, estimates based on various prices of raw materials and several processes are given.

Locations of the Government synthetic rubber plants are given and U.S. rubber consumption (1941–4, 1945–6 estimated) and production (1942–4, 1945–6 estimated) are shown in graphical form. T. M. B. M.

**410. Many New uses Found for Petroleum Waxes.** R. B. Killingsworth. *World Petr.*, Oct. 1945, **16** (11), 55.—War-time demand for microcrystalline wax, mainly for packaging, has increased production from 20 million lbs in 1939 to 120 million lbs in 1944. Solvent deoiling of slack waxes is increasing in importance, the total production of crude scale and refined paraffin waxes produced by this method and by normal sweating having passed the 500 million lb mark in 1940. Solvent dewaxing of residual lubricating stocks is replacing cold settling for the manufacture of petrolatum, and this product has now become an important source of microcrystalline wax by controlled fractional crystallation with solvents or solvent deoiling. 80% of the paraffin wax production is used in moisture-proof packaging material. It is also used in milk containers, cereal boxes, drinking-straws, and in the form of emulsions used in beater sizing or top sizing of paper. The main advantage of microcrystalline waxes is their flexibility at low temperatures, so that the most important use is in the packaging of military equipment, a satisfactory series of coatings for metal parts consisting of: (1) a rust preventative; (2) greaseproof paper wrapping; (3) molten microcrystalline wax laminated and coated paper wrappings; and (4) molten microcrystalline wax dip-coat. Other uses are in food packaging, particularly in the form of laminated papers, in water-repellent fabrics, electrical insulation, as substitute for beeswax in inks, polishes, cosmetics, etc., in acidproof linings, and in the printing, rubber, and ceramic industries. C. L. G.

**411. Domestic Fly Sprays (1) Introduction.** C. L. Gilbert. *Petroleum*, Feb. 1946, **9** (2), 34.—The use of fly-sprays dates only from 1919, but by 1939 over 5,000,000 gals of domestic fly-sprays were sold annually in the U.S.

A fly-spray consists of a solution of a toxic agent in a petroleum distillate. Originally pyrethrum and rotenone were the toxic agents, but synthetic products, chiefly D.D.T. are replacing these. A recent development is the aerosol type of spray, whereby a persistent mist of very fine particle size is produced.

In the U.S. specifications for household sprays have been drawn up, grading of the sprays being based on the percentage kill on flies by the Peet-Grady method.

Spraying equipment varies from the domestic to the large power-operated sprays of factories, warehouses, etc.; and small bombs containing kerosine solutions of insecticides under air or $CO_2$ pressure have also been used in the field.

Freon 12 (dichlorodifluormethane) is widely used as carrier in aerosol bombs.

Specification recommendations have been made on quality of carrier, including distillation range, flash point, colour, viscosity, and odour; and the effect of viscosity on the kill has been studied.

Of the toxic materials, pyrethrum, extracted from the flowers of *Chrysanthemum cinerariæfolium*, and cultivated in Dalmatia, Japan, Kenya, Brazil, etc., was most widely used.

The dried flowers are solvent-extracted with kerosine or ethylene dichloride. The toxic principle of the pyrethrum is pyrethrins I and II, and the extract is toxic to a wide variety of household and horticultural pests. Toxic action is believed to be due to destruction of cells of the nervous system associated with paralysis.

Rotenone is extracted from roots of plants of the Derris genus, growing in the East Indies.

The ground root, and extract, is used against some horticultural and agricultural pests, but use is limited owing to relative insolubility in kerosine. It is more stable than pyrethrum, and effect on insects is due to interference with oxygen adsorption rather than nerve poisoning. G. A. C.

## Derived Chemical Products.

**412. Utilization of Natural Gas in the United States.** G. G. Oberfell. *Oil Gas J.*, 15.12.45, **44** (32), 76.—This article reviews the past, present, and future uses of natural gas in the United States. While considerable quantities are employed in carbon-black manufacture, the use of natural gas as fuel is likely to increase greatly. As a raw material in the manufacture of chemicals it is of considerable importance, but the quantity used is, and probably will be, relatively small compared with its other uses.

It is considered to be a more economical raw material than coal for conversion to liquid hydrocarbons by the Fischer-Tropsch process, especially where modifications of this can be combined with other processes—to manufacture, for example, gasoline and various chemicals. It is thought, however, that the Fischer-Tropsch process would not be competitive with present refinery operations using crude oil as a raw material, under present prices. Also, the peak of gasoline production from natural gas by Fischer-Tropsch would undoubtedly amount only to a small proportion of the nation's total gasoline supply.

A table showing the efficiencies of gasoline production from both coal and methane (the latter by two processes) is given, together with a graph showing the energy supplied annually by coal, petroleum, natural gas, and water power. T. M. B. M.

**413. Petroleum By-products. A Big Factor in Organic Chemical Industry.** Anon. *Chem. Met. Eng.*, 1945, **52** (12), 121.—The great variety of products which may be derived from methane, ethylene, propylene, butane, butylenes, and pentane is discussed. The relationships between starting materials and products are illustrated diagrammatically. L. B.

**414. German Carbide Chemicals. Plant and Processes at the Knapsack Works.** Anon. *Chem. Tr. J.*, 1.2.46, **118** (3063), 137.—A digest of C.I.O.S. Report No 22-XXVII-83, which relates to the plant at Knapsack of the A.G. Gesellschaft für Stickstoffdünger owned by the I.G., believed to be the largest single carbide manufacturing unit in Germany. Of outstanding interest are a continuous cyanamide manufacturing process and batch processes for the simultaneous production of acetic acid and acetic anhydride from acetaldehyde.

Calcium carbide was produced in 11 furnaces, 7 of the old type (1921–1931) and 4 of the new type (1931–1938). The former operated at 10,000 kw producing 60–70 tons of carbide in 24 hrs. Power characteristics were: 3-phase, 50 cycles, 86% power factor, primary voltage 600, voltage across electrodes 118–151. 4·4 kwh were required per kilo carbide. The new furnaces operated at 23,000 kw, producing 150 tons carbide per day with power characteristics: 3-phase, 50 cycles, 92% power factor, voltage across electrodes 125–181. 3·2 kwh required per kilo of carbide.

Calcium carbide was converted into cyanamide by passing nitrogen over the carbide in presence of a calcium chloride/fluoride catalyst at 700° C in 6 tunnel furnaces, each having a capacity of 25-30 tons per 24 hrs. Acetylene prepared by a wet or dry process from the carbide was used for the production of acetaldehyde by passing it through suitable towers filled with a 10% solution of a 50% mixture of ferrous and ferric sulphates. The exit gas was purified and distilled to 99·2% acetaldehyde.

Two processes were used for acetic acid manufacture from the acetaldehyde, the older feeding the aldehyde mixed with oxygen over magnesium acetate catalyst. The newer process produced acetic acid and acetic anhydride, using cobalt or copper acetate as catalyst at 40° C in presence of oxygen. The reaction products were separated by fractionation.

For acetone manufacture 95% acid was vaporized and heated to 400° C, being subsequently converted at 400–420° C by means of a cerium acetate catalyst. Purification was effected by distillation. T. M. B. M.

**415. Propylene in Chemical Industry.** Anon. *Petroleum*, Feb. 1946, **9** (2), 30.—Propylene can be derived either from coal or petroleum, about 100,000 tons being present in the town and coke-oven gas produced annually, and an estimated potential of 2,000,000 tons from refinery gases throughout the world.

In the U.S. and to a small extent in this country, the $C_3$ and $C_4$ fraction is bottled

and sold under trade names, *e.g.*, calor gas; some 460 million gal being produced in 1941.

A diagram shows the more important chemical derivatives including glycerol and acetone which may be obtained from proplyene. G. A. C.

## Coal, Shale and Peat.

**416. Shale Oil.** Anon. *Engineer*, 21.12.45, **180**, 498; 28.12.45, **180**, 520.—The history of shale oil is briefly outlined, together with a description of the various forms of shale and localities in which it is found, together with some production figures in various parts of the world.

Like coal, shale differs in quality with the different districts in which it is found, and occurs in seams usually near the surface. Processing plant is usually situated near the source of the shale, and yields products of the paraffinic and olefin series, together with ammonia liquor and sometimes phenol, when subjected to destructive distillations. In addition, gas is liberated which can be used for heating the retorts and for illumination, etc.

Improvements in production technique have resulted in a higher proportion of motor fuel and diesel oil being produced. Figures for the yields of typical shales on treatment in a Salerno plant are given.

Details of operation of various treating plants are described, including the Pumpherston, Pintoch and Davidson retorts.

The modern Salerno retorts is dealt with in some detail, and its operating cycle explained.

In Part II of the article the modern Davidson retort, which operates on an entirely different system, is described. Originally designed to handle Estonian shale, it consists essentially of a drum 75 ft long and 4 ft diameter, having a slight fall towards the discharge end and rotating at about one revolution in 2½ min.

An internal stationary tube of D section, with suitable inlets, collects the products of carbonization. The bulk of the dust which is deposited in this tube is finally eliminated in a centrifugal collector. Reciprocating scrapers mounted on the outside of the stationary tube and in contact with the moving inner surfaces of the retort remove depositions. Accumulation of dust is prevented by the provision of reciprocating push-plate cleaners worked in conjunction with the scrapers. The stationary drum is supported on roller bearings surrounding reduced necks made on the tube.

The rate of feed to the retort is controlled automatically. Depth of shale in the retort is important, and the cross-sectional area of the bed should be more than one-third that of the retort, to prevent sliding and to give maximum carbonizing efficiency. Heat for carbonizing is supplied by spent shale containing about 15% combustible material, and may be supplemented by gas from carbonization if necessary. The hot spent shale is conveyed to the special furnace without appreciable heat loss.

With a working temperature of 500° C the retort described can handle 1 ton of shale per hour in fragments not less than 3 in cube.

Shale oil may be hydrogenated to increase the yield of motor spirit, and this may be done simultaneously with the carbonizing process by the decomposition of the water in the shale or by added steam. Various British and American patents for hydrogenation are described. C. D. B.

**417. Thermal Solution.** M. K. D'Yakova. *Petroleum*, Dec. 1945, **8** (12), 227.—A new method of thermal processing of solid fuel for its conversion into liquid employs conditions in which the organic portion of the solid fuel undergoes appreciable decomposition. Essentially it is a process of disaggregation of the colloidal complex by the solvent. The solid fuel is ground to 0·2–5 mm, mixed with equal weight of solvent, heated to 380–430° C for 10–30 min at 30–40 atm. After the reaction the mixture is distilled. The process has wide applicability, and a much higher proportion of organic matter is converted to liquid form than by other processes.

A wide variety of substances may be used as solvents, including petroleum, fuel oil, tar distillates, and compounds such as tetralin.

Tables are given showing yields from shale, wood, peat, cellulose, and coals.

G. A. C.

**418. Alternative Sources of Liquid Fuel.** W. D. Spencer. *Petroleum*, Dec. 1945, **8** (12), 228.—The rapid depletion of wood reserves, with the slow rate of regeneration, resulted in replacement by more suitable materials in industrial countries. After the exhaustion of other forms of carbonaceous matter it may be necessary to rely on plants for energy requirements.

In the Berl two-stage process, involving the application of heat and pressure, the raw material is plant and waste agricultural material such as molasses, sawdust, and potatoes.

A conversion efficiency of nearly 50% was obtained on Louisiana dry sugar-cane, yielding a mixture of light hydrocarbons and raw sugar; but the process, like others producing liquid fuels and chemicals from coal, is uneconomic.

In Britain the best accessible coal seams are being worked out, but peat, lignite, oil shale, and other bituminous matter reserves are greater than commonly thought. One quarter of the total reserve of 200,000 million tons of peat occur in the British Empire, including about 12,000 million tons in the British Isles.

Tar sands in Canada could produce 250,000 million brl of oil, comparing with a total probable reserve of 20,000 million brl of oil in the U.S.A. G. A. C.

## Miscellaneous Products.

**419. Some Novel British Patents on Fuel and Power.** C. Ridley. *Petrol. Times*, 5.1.46, **50**, 20.—Abstracts are given of various recent patents relating to fuel and allied matters.

Bugatti has been granted a patent (No. 11,840) for a hydraulic coupling which differs from the normal fluid flywheel which has its own self-contained oil supply, by specifying that engine oil is to be supplied from the engine pump.

Patent 571,814 of the Telegraph Construction and Manufacturing Co. specifies a process for the manufacture of polyethylene by dissolving the substance in a hot solvent in which it is insoluble at a lower temperature. The precipitated powder can be sprayed by a metal gun in the well-known manner.

Patented by an American, British Patents 572,091–92 deal with non-metallic submerged bearings suitable for boat propellers, along which grooves are cut allowing the water to flow along the bearing forming a lubricating film. The Rover Co. have been granted a patent (572,080) for the application of the exhaust gases from the engine to disperse the liquid fuel and convert it to a fine spray on its discharge from the injection nozzle.

British patent No. 572,012, recently granted to the Shell Development Co., provides for a special lubricating-oil composition for turbines and for dielectric use. The additive which renders the oil highly resistant to oxidation and gum or sludge formation is 2 : 4-dimethyl-6-tertiary octyl phenol in proportions of 0·05–2% wt.

British Patent 571,539, granted to the Cincinatti Milling Machine Co., relates to the salvaging of the power expended in the machining of metals. The process is a chemical one, and uses the waste heat to initiate certain chemical reactions which, while not being possible at ordinary room temperature and pressure, are started and continued under the influence of high temperatures and pressures. The process described includes the supply of a fluid to a chamber enclosing the operation of a tool cutting chips from a metal rod, which continuously imposes fresh nascent surfaces sensitive to chemical reaction with the fluid supplied. Aluminium is one of the metals used, and the fluid supplied for the reaction is carbon tetrachloride, the product being hexachlorethane. T. M. B. M.

**420. Wood-Preservatives Standardization. An Interim Classification Scheme.** Anon. *Chem. Tr. J.*, 1.2.46, **118** (3063), 160.—A committee of the Wood Preservative Section of the British Standards Institution have considered the preparation of a specification for wood preservatives based on laboratory performance tests. The efficiency of a wood preservative depends mainly on: (i) Toxicity towards wood-destroying fungi; (ii) Penetrating power; (iii) Resistance to leaching, evaporation and decomposition. B.S. 838, "Method of Test for Toxicity of Wood Preservatives to Fungi," is not thought to be a complete method of assessing toxicity under practical conditions, and at the present juncture it has not been found possible to devise acceptable tests for (ii) and (iii).

As an interim measure for the guidance of users, the B.S.I. has issued BS 1282;

1945 "Classification of Wood-Preservatives." All wood preservatives which should comply with the B.S. method of test for toxicity as described in Appendix A to the specification are classified into: (*a*) Tar oil; (*b*) Organic solvent; and (*c*) Water solution types. The normal properties of each type are described and methods of application and impregnation are discussed. T. M. B. M.

**421. Artificial Waxes from Lignite. (The German Montan-Products Industry.)** Anon. *Chem. Tr. J.*, 8.2.46, **118** (3064), 171.—The report compiled by the British Intelligence Objective Sub-Committee on information obtained on the technology of the German montan-wax industry from chemists employed by the I.G. at Oppau is discussed.

The only lignite deposits in Germany suitable for montan-wax production are those at Halle Riebeck, which have a wax content of 15%. The raw material and crude wax extraction plant are in the Russian zone, and the further refining facilities are in the American zone.

At Halle Riebeck the lignite is powdered, dried, and extracted in a Soxhlet-type plant with a boiling mixture of 80% benzene and 20% ethyl alcohol. The crude wax, which is obtained by evaporation, consists of 70% wax, 15% resin, and 15% bituminous material, is similar to carnauba wax having an acid number of 35–40, and consisting mainly of approximately 25% of montanic acid and 75% of montanic acid esters and a small amount of free alcohols.

Before further processing, the crude wax is powdered and treated in the cold with the same solvent mixture as above in order to remove resin, the wax then melts at 83–85° C. The various brands of I.G. waxes were obtained from this material by further treatment; thus I.G. Wax S was prepared by oxidation with a mixture of chromic and sulphuric acids at 110–120° C, and consisted mainly of $C_{24}$ to $C_{30}$ fatty acids with 15% of unreacted esters, having a melting point of 83° C and an acid number of 145–150. Wax S did not find wide use, but was employed as a starting material for others. Wax E was the glycol ester of Wax S, and was used for aqueous emulsions and creams. Wax O consisted of 60% Wax E and 40% of the calcium salt of Wax S, and is considered to be the best substitute for carnauba wax. Wax BJ (beeswax substitute) was a mixture of Wax S and palmitic or stearic acids all esterified with ethylene glycol and modified with 15% 50° C m.pt. paraffin wax. Wax Z with its high m.pt. (100° C) and water resistance was used for electrical work, and was prepared by ketonizing the Wax S fatty acids by heating at 300° C in presence of 1–2% of iron powder. T. M. B. M.

**422. Statistics on Production of Plastics.** Anon. *Modern Plastics*, Dec. 1945, **23** (4), 134.—Data on the production of plastics in the U.S. from 1940 to 1944 reveal that expansion is continuing, but at a reduced rate. The 1944 total production of synthetic resins amounted to 784 million lb, compared with under 277 million lb for 1940, while for the same years production of cellulose plastics increased from under 36 million lb to nearly 81 million lb. Of the synthetic resins, the cyclic type represented slightly more than half, the phthalic anhydride-glycerol products being in largest production, followed by the phenol formaldehyde type. The protective coatings industry absorbed the largest proportion of synthetic resins (293 million lb), mainly phthalic anhydride-maleic anhydride—and abietic acid—alkyd resins. Mouldings and castings absorbed 120 million lb, the remainder being used in adhesives, laminations, treatment of textiles, paper, leather, in glazing, sheeting, films, etc. Of the acyclic type, the polyvinyl products were of the most importance.

Data are included for the 1944 production of plasticizers (179,376,000 lb) and of elastomers (1,763,227,000 lb). The production of elastomers included the following: Polybutadiene-styrene (GR-S) 1,500,993,000 lb; Polybutadiene-acrylonitrile (GR-A) 37,731,000 lb; Polychloroprene (GR-M) 105,957,000 lb; Polyisobutylene-diolefin (GR-I) 42,315,000 lb; and Polyisoprene 370,000 lb. C. L. G.

## Engines and Automotive Equipment.

**423. Piston Ring Problems.** J. S. Courtney-Pratt and G. R. Tudor. *Engineer*, 7.12.45, **180**, 469.—The authors outline a method of investigating the breakdown of the lubricant film between the piston ring and cylinder liners of an I.C. engine as a factor effecting wear.

The equipment used consisted of a small gasoline engine in which the piston was fitted

with an insulated piston in the second groove. Connection was made by leads attached to the back of the ring, and led down the con-rod and through the case by means of a link motion. The electrical circuit was completed through the cylinder liner. The potential drop across the oil film was measured and recorded continuously throughout the cycle by means of a cathode-ray oscillograph and camera, and was taken as a measure of the film thickness. From results obtained the following observations were made :

The piston and cylinder wall were never separated by a continuous oil film, and lubrication improved with speed. The breakdown of the film was most marked near the ends of the stroke, where sliding velocities were low and the greatest wear occurred.

Only slight deterioration was observed with increase in gas pressure, but an increase in oil viscosity showed a marked improvement. With oils of any viscosity increase in temperature greatly reduced the thickness of the lubrication film.

For minimum wear the engine should be operated as cool as possible, the lower limit being the dew-point of the combustion products. The warming-up period should be as short as possible.

Since for high efficiency high operating temperatures are necessary, the authors suggest the use of " addition agents " to maintain effective lubrication at high temperatures.

The method outlined is said to be sensitive, and conditions of lubrication throughout the cycle and changes due to operating conditions that were likely to effect the rate of wear could be analysed. C. D. B.

**424. Piston Ring Problems. An Improved Method of Measuring Piston-Ring Wall Thrust.** B. Pugh. *Engineer*, 7.12.45, **180**, 471.—Considerable care must be exercised in the selection of piston rings if reasonable repeatability of tests and of oil consumption is to be obtained. Examination of rings after test may also give useful information of what has happened during the test.

An apparatus developed by the author for the accurate measurement of the polar-ring thrust pattern is described.

It consists essentially of a ring-holder bored to the cylinder size, recessed, and screwed in the rear portion to take an adjusting ring. A crossbar carrying a micrometer screw and dial is attached to, but insulated from, the ring-holder. Load is applied to the ring by a plunger operated by one end of a balance arm mounted below the base plate.

When load is applied, the deflection of the ring is measured by the micrometer making electrical contact with the inside of the ring, indicated by a voltmeter. Deflections of one-half of one-ten-thousandths can be measured.

Extrapolation to zero deflection of the linear portion of a graph obtained by plotting deflection against load for various positions of the ring gaps gives the ring wall thrust at each point of its circumference. C. D. B.

**425. Piston Ring Problems. An Improved Method of Measuring Piston-Ring Wall Thrust.** B. Pugh. *Engineer*, 14.12.45, **180**, 491.—Piston-ring " sticking " in petrol engines is caused by the deposition in the ring grooves of oil deterioration products, wear and corrosion products and lead from the fuel, and the degree of sticking under given conditions is effected by the properties of the oil. It is the chief criterion of most tests to rate oils according to their deterioration characteristics in an engine cylinder. The notes are based on experience of the author of running 50, 50-hr tests to develop a specification test for aero oils in a single-cylinder poppet-valve air-cooled unit, and in assessing the mechanical factors which may effect ring-sticking, with special reference to ring and ring-groove wear, and oil consumption.

The effect of " shut down " on the mechanics of ring deposits and direct and indirect methods of indicating ring-gumming are discussed.

Piston-crown temperature is considered to constitute the best method of control for oil tests, with temperature measurement behind the rings to give evidence of the commencement of sticking. A method of measuring piston temperatures is described with some typical figures obtained on a 500-cc single-cylinder unit. Anything which prevents or restricts ring rotation or movement will accelerate gumming.

Mechanical factors will effect, and may reverse, the relative rating of oils, and those which cannot be controlled must be considered in assessing engine data, or when

formulating a laboratory test simulating engine conditions. Correlation between engine and laboratory tests is best based on the time to give incipient ring-sticking rather than the degree of sticking produced after a definite time. C. D. B.

**426. Operating Report on Gas-Turbine Use in Sun Oil Company Refineries.** A. E. Pew. *Oil Gas J.*, 11.8.45, **44** (14), 118.—Regeneration of spent catalyst in large cracking units requires vast quantities of air. The Houdry Corpn. in collaboration with the Sun Oil Co., have since 1936 adopted gas turbines and axial compressors for the purpose. For plants of 10,000 brl/day air requirements for the regeneration are about 40,000 cu ft/min. at 45 p.s.i. Normally turbine inlet gas temperatures vary from 875° to 950° F at 40 p.s.i., the outlet pressure of the compressor being about 50 p.s.i. A table is given of turbo-compressors in service on static bed Houdry units, 12 supplying 23,000 cu ft/min; 13, rated at 40,000 cu ft/min and one giving 60,000 cu ft/min; the types being Brown-Boveri and Allis-Chalmers, with speeds of 5180 r.p.m. The equipment of the 40,000 cu ft/min, their constructural materials and method of operation are described. Diagrams are given of the pressure burners and of the hook-up of the starting motor, asynchronous generator, turbine, blower and pressure burners with the salt heat exchanger, cracking chambers, and combustion case for the regeneration process. The angular contact ball thrust bearings of the turbo-compressors have been replaced by the Kingsbury-type bearings, which will be employed in all new installations. A summary of the turbo-compressor operations up to May 1945 shows the number of operating days, the number of days lost through breakdowns, and the percentage of time lost due to turbo-compressor troubles, and an analysis is given of the causes of breakdown due to bearings, lubrication, blades, air-seals, explosions, and miscellaneous troubles. These are fully discussed. Under normal operating conditions the amount of excess power supplied to, or developed by the unit depends on the type of catalytic cracking reaction being practised—*i.e.*, with increase in carbon deposition, power will increase. In general, with air at 60° F to the compressor, and with a gas temperature to the turbine at 950° F, the 40,000 cu ft/min unit will generate up to 900 Kw excess power than that required for driving the compressor. The quantity of air delivered by the compressors described fluctuates less than 1% for 20% variation in discharge pressure, compared with a 20% fluctuation, or more, for similar changes when centrifugal compressors are employed. W. H. C.

**427. Oil-Burning Locomotives on the G.W.R.** Anon. *Petrol. Times*, 5.1.46, **50**, 16.—Eighteen heavy freight locomotives are being converted experimentally by the G.W.R. at Swindon to burn heavy fuel oil instead of coal. The oil-burning equipment consists essentially of a Weir-type burner, an oil-regulating cock and heater, and a steam manifold carrying the necessary control valves. The fuel-tank, which is lagged, and the front compartment of which is steam heated, has a total capacity of 1800 gal. A standpipe from the tank has a filter fitted, and then passes through an auxiliary heater to the burner.

The burner is of the type in which oil flows over a weir on to a ribbon of steam, by which it is caught up, atomized, and projected toward the back of the firebox.

All the converted engines will be used in South Wales for coal and freight traffic, and it is anticipated that runs of about 250 miles will be possible between refuellings. Two refuelling depots are under construction, one at Llanelly and the other at Severn Tunnel Junction, which will each have a storage capacity of 36,000 gal.

The annual saving of coal effected by the conversion of these 18 engines will be approximately 13,000 tons. T. M. B. M.

## MISCELLANEOUS.

**428. Control Occupational Hazards through Industrial Hygiene.** N. V. Hendricks. *Chem. Met. Eng.*, 1946, **53** (1), 124.—The purpose of the article is to emphasize the importance of the hazards of atmospheric contamination. The safe atmospheric concentrations and the physiological effects of a large number of toxic materials are listed in a table, and methods of protecting personnel discussed. L. B.

**429. British War Devices in 1945. I.** Anon. *Engineer*, 1946, **181**, 31–33.—Information concerning "Pluto" was released on 24th May, 1945, (see Abstract No. 1028/1945).

Details of " Operation Fido " were made public on 1st June, 1945. " F.I.D.O." (Fog, Intensive, Dispersal Of) was in effective use from the winter of 1943 onwards. The method consisted of evaporating fog locally by direct air heating, using burning petrol vapour as the source of heat. The " Haigill " burner (Hartley, Anglo-Iranian, Gill) was installed in 13 operational airfields. One of the last types of burner to be developed, the " Slot " burner, consisted of a hairpin-shaped tube in which flames from petrol vapour, issuing from orifices in the lower limb, impinged upon the upper limb and vaporized the petrol flowing through it. The whole installation was below ground level, so as not to interfere with traffic, and was operated from a switchboard in a central control room. Plans were made to instal fully automatic equipment at Heathrow airfield, the chief airport for London. There were to have been 12,000 yd of burners, capable of burning petrol, when in full use, at the rate of 100 tons per hour. Owing to the high cost of operation, estimated at £450 to land a large transport aircraft, the Fido installation at Heathrow has been abandoned. A. C.

**430. British War Devices in 1945, II.** Anon. *Engineer*, 1946, **181**, 54–55.—Among the exhibits of sea-flame barrage, fougasses, and mobile flame-throwers shown at the Petroleum Warfare Department exhibition in London in October 1945, was a small-size flame-thrower, built for research purposes, with a nozzle diameter of a few millimetres, compared with about 1 inch in the full size. It was found that to increase the range of the flame either the nozzle diameter or the viscosity of the fuel had to be increased. The first alternative was impracticable for fuel consumption reasons using mobile apparatus, and the second gave rise to high-pressure drops in fuel ducts and nozzle. The difficulty was overcome by using a petrol " gel," which acted as though its viscosity were low in the ducts and nozzle and high in the jet. Reasons are also given for the fact that the ignited jet has an effective range of about twice that of the cold unignited jet. A. C.

**431. German Petroleum Industry in the Hamburg District.** Anon. *Petrol. Times*, 19.1.46, **50**, 73.—A review is given of C.I.O.S. report XXXII–94, which consists of 15 reports on the petroleum refining industry in the Hamburg area, including Bremen and Kiel, and includes the performance, utilization, testing of products, and research.

*Report No.* 1. *Interrogation of Technical Staff at Shell Haus, Rhenania-Ossag.* (a) *Aircraft Engine Oils.* At the beginning of the war two main oils (approx 100 sec Saybolt at 210° F) were available: Aeroshell Mittel, a blend of 15% Endvoltol with 85% Edeleanized oil of the Venezuelan type; and Intava or Rotring 100, a Duosol residue from American or German paraffinic crudes. The use of the Voltol blend decreased as the War progressed, and blends of synthetic oil with Edeleanized indigenous oil were later adopted. No V.I. raisers were incorporated in aero-oils, but non-metallic additives claimed to inhibit oxidation and ring sticking were added where necessary.

(b) *Voltol.* No Voltol was made by chemical catalysis (*e.g.*, $BF_3$) and in general the main product was Endvoltol made from 33⅓% rape oil and 66⅔% mineral-oil distillate.

(c) *Basic Oils and Additives.* The quality of the oils for the services was maintained to the end, but oils for civilian use underwent marked deterioration. The steam cylinder oil position became difficult owing to shortage of dewaxing equipment for treating residual oils. Among the substitutes developed were " emulsion lubricants." Shortage of bright stocks for engine oils was relieved by the manufacture of high viscosity synthetic oils.

(d) *Motor Oils.* Oppanol (P.I.B) was used to some extent to obtain flat viscosity/temperature curves, but fear of gummy piston deposits limited its use for Army vehicles. No H.D.-type additives appear to have been developed for use in high-speed diesels or other I.C. engines.

(e) *Gear Oils.* Shortage of fats led to the use of lead naphthenate plus free sulphur in these oils in 1942. Other E.P. compounds used by the Wehrmacht were: (i) a sulphur compound made by treating a cracked wax olefin with sulphur monochloride; (ii) " Etrol "—apparently a nitro-compound plus free sulphur and some fatty oil.

(f) *Greases.* Shortage of fatty oils led to the use of tallow, oxidized paraffins, and Montan wax. Two lithium stearate greases were developed.

(g) *Cutting Oils and Rust Preventives.* Economy was effected by using weaker slurries and increasing slightly the amount of emulsifier used. A soluble cutting oil made by treating a synthetic gas oil with sulphur monochloride was developed.

(h) *Hydraulic Oils.* A low-pour-point Edeleanized asphaltic base oil blended with 3% Voltol was supplied to the Luftwaffe.

(j) *Marine Engine and Torpedo Oils.* Blown-fatty oils in blends were substituted by montan-wax soaps.

(k) *Emulsion Lubricants.* A mineral oil containing an emulsifier was supplied to the user, who stirred in an equal volume of water, and used the resulting water in oil emulsion as a lubricant. As emulsifiers, montan wax, an oxidized synthetic wax, and Voltolized unrefined ozokerite were supplied.

(m) *Extracts.* Endeleanu extracts were used as rubber extenders, printing-ink components, putty substitutes, and for many other purposes.

(n) *Asphaltic Bitumen.* Crudes available for production of asphalt were Roumanian, and certain indigenous oils. Colophony and related wood products were widely used for emulsification of bitumen.

(o) *Research.* A number of research projects were instigated. Two items of particular interest were: (i) the use of vapour $AlCl_3$ to prepare lubricating oils from olefins; (ii) the development of silica gel-oil grease made by compounding 9% specially prepared gel with an oil free of polar substances.

*Reports Nos. 2 and 3. Harburg and Grasbrook Refineries of Rhenania-Ossag.* A description is given of refinery operations during the war using for the most part indigenous crudes.

*Report No. 4, Deutsche Vacuum Oel A.G.* A description of the refineries at Schulau and Oslebshausen. The first-named refinery was old and of little technical interest, but the latter possessed a Duosol plant with some novel operating details. Emulsion oils as well as cutting and soluble oils were made at Schulau, and were of the same type as described in Report No. 1. Intava research and engine-test laboratories operated in this district.

*Reports 5, 7, 8, 9, 10.* These deal with refineries operated by the various companies and making a variety of products.

*Report* No. 6. A brief report outlining the type of equipment used for engine-testing fuels and lubricants at Rhenania-Ossag laboratory at Tiessau.

*Report* No. 11, *Chemisch-Physikalische Versuch Anstalt der Marine at Dänisch-Nieuhof.* Here was concentrated all German Naval research, except radar. The most interesting section is that referring to the work on spontaneous ignition temperatures leading to the definition of a characteristic quantity—the "priming value" of oils.

*Report No.* 12. Interrogation of Dr. Kurt Wissel of the Stettin Hydrogenation works.

*Report No.* 13. *Reichinstitut fur Erdolforschung der Technische Hochschule at Hannover.* A considerable amount of fundamental research was carried out which has not yet been properly assessed. Some valuable work on solvent dewaxing included determinations of the solubility of pure hydrocarbons in a wide variety of solvents. A colour reaction for the detection of hydrocarbons containing tertiary carbon atoms sensitive to 0·01% was developed.

*Report No.* 14. *Interrogation of Dr. Hans Hartmann Director of Norddeutsche Mineraloelwerke Pölitz.*

*Report No.* 15. *Description of German Underground Plants.* A description of the various types of underground plants based on interrogations in the Hamburg area, includes details of 15 different kinds of unit, some of which were completed, and some only projected. D. L. S.

# BOOKS RECEIVED.

**1945 Supplement to A.S.T.M. Standards including Tentatives. Part II. Nonmetallic Materials—Constructional.** Philadelphia, Pa.: American Society for Testing Materials, 1945. Pp. 229 + x.

This supplement to Part II of the 1944 Book of A.S.T.M. Standards contains the newly adopted and revised standards and tentatives in the nonmetallic constructional materials field accepted since the publication of the 1944 book.

**Journal of the Iron and Steel Institute,** Vol. CL, 1944. London: Iron & Steel Institute, 1945. Pp. 683 + x.

This volume contains the twelve papers presented at the autumn, 1944, meeting of the Institute and includes "The Bonding Properties of Mixtures of Petroleum Extracts and Linseed Oil and of the Extracts Themselves," by W. Davies and W. J. Rees. It also contains abstracts of articles on the manufacture and properties of iron and steel.

**Transactions of the Institution of Chemical Engineers.** Vol. 20, 1942. London: Institution of Chemical Engineers, 1946.

This volume of the Proceedings of the Institution of Chemical Engineers during 1942 contains papers on "The Evaporation of Liquids in Currents of Air," by S. H. Wade, and "The Representation of Vapour–Liquid Equilibrium by Means of a New Graphical Method," by A. L. Bloomfield.

**Journal of the Junior Institution of Engineers.** Vol. LV, 1944–45. London: The Junior Institution of Engineers, 1945. Pp. 364 + viii.

Among the papers read before the Junior Institution of Engineers and included in the present volume were "The Rudiments and Industrial Applications of Distillation Processes," by C. Hunnikin, and "The History and Present Practice of the Tar Distillation Industry," by W. G. Adam.

**Manual of Firemanship. Part 6B. Practical Firemanship—II.** London: H.M. Stationery Office, 1945. Pp. 169 + iv. 2*s.* 6*d.* (*Post free:* 2*s.* 10*d.*)

Issued under the authority of the British Home Office (Fire Service Department), this part of the *Manual of Firemanship* deals with the practical side of firefighting and contains a useful chapter on fires in oil installations and tank farms. It contains excellent illustrations of equipment and of actual firefighting operations.

**1945 Supplement to A.S.T.M. Standards including Tentatives. Part III. Nonmetallic Materials—General.** Philadelphia, Pa.: American Society for Testing Materials, 1945. Pp. 505 + xiii.

This supplement to Part III of the 1944 Book of A.S.T.M. Standards contains the survey adopted and revised standards and tentatives in the nonmetallic general field. It includes petroleum products and lubricants and industrial aromatic hydrocarbons.

# ABSTRACTS.


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## OILFIELD EXPLORATION AND EXPLOITATION.

### Geology.

**432. Schist Production is New Development at Edison.** L. P. Stockman. *Oil Gas J.*, 29.12.45, **44** (34), 165.—The Edison pool, California, was discovered in 1934, and has produced over 13,038,170 brl of oil. At the beginning of 1945 the output was 3683 brl/day, but is now 8563 brl/day as a result of developing new reserves in the fractured, weathered schist basement, and in two small adjacent pools at Playa del Rey there is production in both fractured schist and basal conglomerate, while Santa Maria Valley yields oil from the Knoxville sandstone and fractured Franciscan basement, which involves penetrating the basement for about 100 ft.

The Edison structure is a southwest-dipping monocline, with some rapid lithological changes and progressive overlap in places. The top of the basement schist is undulating, but rises generally to the east and northeast. The maximum penetration of the

schist is 880 ft, and the present average 375 ft. The fractured weathered schist is immediately below a relatively thin hard schist member. The drilling of 350 ft of fractured and weathered schist generally requires about two days.

Formerly the Edison production ranged 1250–2500 ft in depth. The new production is 2300–3022 ft deep. Schist production may cover 1000 acres, with a recoverable reserve estimated at 15,000 brl/acre. G. D. H.

**433. More Manpower, Materials Spur Wildcat Completions.** Anon. *Oil Wkly*, 31.12.45, **120** (5), 17.—363 exploratory wells were completed in U.S.A. in November, making a total of 4018 wildcats in the first eleven months of 1945. The weekly average for November was 91, compared with 82 in October. 22·9% of the November wildcat completions were productive; the figure for October was 13·7%, and for the first eleven months of 1945 18·5%.

This year there have been fewer major extensions to existing fields than in 1944, but there have been 7% more new oilfield discoveries, and 3% more new oil pay-zone discoveries. 6% more gas-fields have been found than in 1944.

Tables summarize the types of discoveries in October and November 1945, and during the first eleven months of 1944 and 1945. The November wildcat completion results are summarized by States and districts, and similar data are given for the first eleven months of 1945.

The November discoveries are tabulated, with some details. G. D. H.

**434. Large Exploration Campaign Under Way in Canada.** C. J. Deegan. *Oil Gas J.*, 29.12.45, **44** (34), 274.—In Alberta the Imperial Oil, Ltd., has 2 seismograph parties, 4 geological parties and 4 wildcat drilling rigs operating; in southern Saskatchewan it has a double-shift seismograph party, 2 geological parties, 4 core-drills, and 2 wildcat rigs; in the Norman Wells area a seismograph party, a gravimeter party, and 3 geological parties operated during the summer. Other companies had 7 seismograph parties, 4 gravimeter parties, and 12 geological parties at work.

A joint aerial photographic survey was undertaken in the Alberta foothills, covering 15,000 sq ml.

The bulk of the drilling activity is in the foothills and plains of Alberta.

In December 1944 gas and condensate were found at 9618 ft in the Madison limestone at the top of the Jumping Pound structure. A well 5/8 ml down flank and 1018 ft lower structurally gave on test gas-cut mud and salt water. A third test is to be drilled.

The Conrad field of the plains area was opened last July. It has about 8 producers, and is comparatively small. The Princess field has several producers, and may be of small to medium size. East of the Viking and Kinsella gas-fields a new gas discovery has been made. Gas reserve estimates for this area range 250–600 thousand million cubic feet. A second new gas strike has been made 6 ml north of the first. Both produce from about 2100 ft. G. D. H.

**435. Brazil Shows Good Geological Possibilities of Commercial Quantities of Petroleum.** H. J. Langley. *Oil Gas J.*, 29.12.45, **44** (34), 162.—Tar and bituminous rocks have been known in the Parana basin since the last century. Devonian and Triassic beds occur, and wells drilled between 1918 and 1935, in Sao Paulo, Parana, and Santa Catarina, produced some oil and natural gas. Work began in the State of Bahia 25 years ago, and in Alagoas exploration was started around Maceio in 1920. Between 1924 and 1935 several wells were drilled in the Papajos valley of the State of Para. Some wells were drilled in the territory of Acre and in the region of Cruzeiro do Sul, commencing in 1935.

Search for oil in Bahia and Alagoas was restarted in 1939, after reorganization of the Government's oil agency.

In the belt of Cretaceous sediments of the Reconcavo region around the bay of Todos os Santas is a graben bounded on the east and west by curved faults some 77 ml apart. In Bahia fields have been discovered at Lobato-Joanes, Candeias, Aratu, and Itaparica. Wildcats have been drilled on a series of structures: Mata do Alianca, Mata de Sao Joao, Camacuri, and Maracangalha.

The Lobato-Joanes field has seeps. Production was found in 1939 at a depth of 700 ft. 7 producers and 10 dry holes have been completed; 2 of the wells are exhausted. The deepest well reached 7379 ft, being stopped in metamorphic rock. There are 3 oil-saturated zones, the lowest being most productive.

Candeias is on a closed asymmetrical anticline, 22 ml north-northwest of Salvador. Oil seeps occur near the axis. Production was discovered in 1941 at a depth of 3760 ft in a sandstone containing lenses of different degrees of coarseness. 26·6° A.P.I. oil is produced with a G.O.R. of 50–75 cu ft/brl. 11 wells have been drilled.

Aratu is 12·5 ml north of Salvador. An upper horizon gives oil and a lower horizon gas. The oil reserves, which are in lenses, are small. Gas reserves are estimated at 1,000,000 M.c.f.

Itaparica is on an anticline with an upper gas-sand and a lower oil-sand in the Cretaceous.

Some data are given on the outputs of individual wells, as well as the production of the fields year by year. G. D. H.

**436. Tests Continue in Shell Well in Eastern Ecuador.** Anon. *Oil Wkly*, 31.12.45, **120** (5), 48.—Vuano 1, on the eastern flank of the Andes, is reported to have shown considerable oil in tests of the Lower Cretaceous at about 5000 ft. Further tests were unsuccessful, and limestones in the Upper Cretaceous with showings are to be tested. G. D. H.

**437. War's End Brings Accelerated Activity in Yumen, China's Only Oilfield.** K. C. Lu. *Oil Gas J.*, 29.12.45, **44** (34), 253.—The Yumen field of Kansu province was opened in 1939. It is on the northern flank of the Chihlienshan Range. The initial well was completed as a pumper at 500 ft. A flowing well was completed in 1941 at 1430 ft. Development was slow because of supply difficulties, but since the war ended expansion of the production and refining capacity has been begun.

Production is from two Cretaceous sands, both medium-grained and of high porosity, and about 150 ft thick. Active seeps occur where the Shihyouho River cuts across the structure, and at an outcrop 2 ml to the east. Little is known about the subsurface structure, which seems symmetrical.

Seven wells were drilled between 1939 and 1941, the average depth of these pumpers being 550 ft. Since then 18 flowing wells have been drilled by rotary rigs. Several oil-sands have been found beneath the lower producing sand.

Drilling and production practices are briefly described. Output is 1500–2200 brl/day. Several topping batteries and a pipe-still have been built, and a thermal cracking plant is being erected. The crude gives about 21% of straight-run high-octane gasoline. G. D. H.

## Drilling.

**438. Economics of Deep Drilling.** I. W. Alcorn. *Petrol. Engr*, Jan. 1946, **17** (4), 75.—A statistical study of all wells drilled below 12,000 ft in the U.S. other than California is made, and the conclusions are that drilling to depths below 12,000 ft is an economically hazardous undertaking. From a study of data used in this compilation combined with a review of published related material it appears that there are three basic factors that deserve considerable emphasis: (1) More emphasis should be placed on drilling costs. This could conceivably follow the line of complete change in drilling methods, as well as more intensive supervision and improvement of present technique; (2) emphasis should be placed on the productivity of possible productive zones. Undoubtedly this will be one of the foremost research problems to be attacked in the future. Present case-histories emphasize the importance of such studies; (3) the third factor is that of probability. This would involve a continuing and more detailed statistical analysis somewhat along the line of this report. A. H. N.

**439. Wells 12,000 Feet and Deeper.** E. Adams. *Petrol. Engr*, Jan. 1946, **17** (4), 93.—Tabulated data are presented of all the wells drilled in the U.S. deeper than 12,000 ft. The number of 12,000-ft and deeper wells drilled each year was:

| | | | |
|---|---|---|---|
| 1935 | 1 | 1941 | 16 |
| 1936 | 1 | 1942 | 17 |
| 1937 | 4 | 1943 | 17 |
| 1938 | 15 | 1944 | 30 |
| 1939 | 23 | 1945 | 65 |
| 1940 | 16 | 1946 | 12 (Drilling) |

Of the 217 wells described in the table of deep wells, 129 were dry, 76 are producers, and 12 are drilling. Of the producers, 31 were plugged back to sand above the 12,000-ft level. Data about the advisability of drilling to deeper levels than 12,000 ft is still too meagre to allow of any definite conclusions being drawn. A. H. N.

**440. Flame-Hardening Tool-Joints in the Field.** R. F. Arnoldy. *Oil Wkly*, 4.2.46, **120** (10), 24.—A flame-hardening unit that can be used in the field is described. The unit carries everything required with it, and in addition to operating during drilling operations will handle the work equally as well where nothing is on location except a rack and the pipe. It will harden 50 joints or 100 ends in 8 hours. The complete job on a 250-joint string can be done in five 8-hour shifts. The hardening element consists of an oxy-acetylene heating head with integral water quench which travels over the joint and progressively heats and quenches a surface depth as it travels. Travel is at variable speed, to compensate for changes in the section. A variable-speed motor with lead screw-drive provides this motion. Oxygen and acetylene are provided from a trailer on which is mounted a 300-lb acetylene generator and 6 standard oxygen bottles manifolded together. Water is supplied from an electrically driven pump. A gasoline-driven generator supplies current for this pump and the main drive-motor. Tanks on the truck are provided, as well as a large gasoline-driven pump, which is used to fill them. The unit is supported on a boom, which raises and lowers it off and on the pipe. The operation, which takes 5 minutes per joint, is described and illustrated. Graphs produced show a smaller rate of wear per ft of depth drilled when the joints are hardened than the rate of untreated joints.
A. H. N.

**441. Drilling Mud Control in the Gulf Coast Area.** F. L. Wallace. *Petrol. Engr*, Jan. 1946, **17** (4), 196.—The materials used in controlling mud in the Gulf Coast Area are listed. Thus, for increasing weight barites is used, and bentonite is employed freely to increase the gel strength of the mud. The following chemicals are used to control viscosity: (1) Crude tannic acid crystals (pH 5·5); (2) Sodium acid pyrophosphate (pH 4·8); (3) Tetrasodium pyrophosphate (pH 9·9); (4) Caustic soda (pH 14·0); (5) Sodium tetraphosphate (pH 7·5). The term pH denotes the degree of alkalinity or acidity possessed by a solution of a substance. The scale extends from slightly below 1 to slightly above 14, the neutral point being the middle, or 7. Thus, a pH of more than 7 would be on the alkaline side and a pH of less than 7 would be on the acid side. The following materials are used to retain circulation: (1) A commercial product made from ground cane-stalks; (2) A commercial product containing small strips of cellophane; (3) A commercial flake mica; (4) A gel-type cement formed by adding a small amount of highly colloidal bentonite to Portland cement either in a wet or dry state; (5) Ground cotton-seed hulls, containing more linters than usually found in cotton-seed hulls; (6) Mixed ungraded chicken feathers; (7) Fine-shredded chicken feathers.

The different types of troubles encountered are discussed, and methods of solving them are given together with illustrative examples. A. H. N.

**441A. Effect of Arsenates on the Viscosity of Drilling Muds.** B. C. Craft and C. M. Moncrieff. *Petrol. Tech.* (*A.I.M.M.E.*), Nov. 1945, **8** (6); *Tech. Pub. No.* 1944, 1–3.—The effect of arsenates on the properties of a bentonite-clay mud has been examined. Tetra-sodium pyroarsenate caused substantially the same reduction in viscosity and water loss as the complex phosphates. The complex arsenate showed a slightly higher reversion after heating for 16 hours than the complex phosphates. Neither trihydrodiorthoarsenate nor sodium dihydrogen orthoarsenate possessed good viscosity-reducing properties.

The arsenates are highly toxic, and their use would be limited in actual practice.
G. D. H.

**442. Trinity's "Big Rig" Capable of Drilling to 20,000 ft in West Texas Area.** E. H. Short, Jr. *Oil Gas J.*, 16.2.46, **44** (41), 90–91.—The prime mover and the transmission system and a few other items of a rig which is expected to drill down to 20,000 ft in West Texas area are described. A. H. N.

**443. 5200 Quarts of Nitroglycerine Exploded in Canadian Well.** G. M. Wilson. *Oil Wkly*, 4.3.46, **121** (1), International Section 25.—In a Turner Valley well 5200 quarts of nitroglycerine were detonated inside the voids of the formation. Using a revolutionary method of handling explosives in connection with well rejuvenation, the engineers, employing only the hydrostatic pressure created by an 800-ft column of water above a 3500-ft column of nitroglycerine, successfully forced back into the crevices of the limestone formation all but 28 quarts of the explosive. Heart of the experiment was in the ingenious device, or "gun," which automatically detonated the charge at precisely the time when all but the last few quarts of nitroglycerine had been forced out into the open voids of the formation. The placing of the explosive and the special shoe used are described. Many interesting and novel effects of the more-than-a-mile deep record explosion were noted by both witnesses at the well and persons living in nearby communities. Contrary to what many of those near the well had believed, the shock was not felt at all at the derrick; in fact, observers standing 100 yards from the derrick had to be told that the blast had gone off. The only effect on the well itself was the lifting of the string of tubing when the shot went off. Prior to the final pouring of the water-tamp, the tubing was anchored down with steel rods and cable, in order to hold to a minimum any possible damage that might be caused by the tubing being kicked out of the hole. When the shot went off, however, these tie-rods were snapped like rubber bands and the tubing string jumped some 6 to 8 ft into the air, then fell back to within 3 to 4 ft of their original position, at which point the packer-slips took hold again. Water in the annular space between tubing and casing also was spilled out on the rig floor—a volume approximately equivalent to the volume displaced by the lifting of the packer. Shock of the explosion appeared to follow the general northwest–southwest trend of the structure. Sharply defining the known faults of the field, the shock-wave did not cross the fault-line into the gas-cap, which is cut off to the east, nor did it pass into the fault to the south. An amateur seismograph made by two schoolboys recorded the shock a mile south of the well. In a nearby town a man was almost thrown from the barber's chair, yet the shock was not noticed by other town-folk. Light snow covering the ground ¼ mile from the well was seen to lift off the ground and remain suspended for a fraction of a second.

A. H. N.

**444. Use and Chemical Removal of Aluminium Pipe.** G. E. Clason. *Oil Wkly*, 4.3.46, **121** (1), 36.—In the California area long, perforated liners are used which allow easy removal for either reconditioning or deeper drilling. In the Illinois area blank sections are used opposite secondary pays, and are removed on the depletion and plugging back from a lower pay. Some few cases exist where the pipe is set through the pay and cemented with a secondary section on the bottom. This may then be gun-perforated, or removed entirely if necessary, to increase production. Oklahoma and North Texas now have many wells with the type of blank section installation usually called windows. There are still many areas where the advantages of this practice have yet to be learned. Use of the aluminium pipe sections should grow as more is known of its resistance to action of corrosive waters and the knowledge of its benefits are more widely disseminated. The removal of aluminium pipe by means of acid and caustic is discussed, but there are several disadvantages to such reagents. Sodium nitrate under certain conditions is found to be effective in dissolving aluminium with the production of sodium aluminate and ammonia. This method is briefly discussed.

A. H. N.

## Production.

**445. Colombian's Operations in Barco Concession Continue Expansion.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 245.—The daily average production in the Barco concession was about 16,500 brl in the third quarter and over 15,000 brl for the first ten months of 1945. The total for 1945 may be 3,850,000 brl from the Petrolea field and 1,650,000 brl from Tibu. 66 wells were producing Cretaceous oil from the Petrolea North Dome in October, 26 were shut in because of high gas/oil ratios, 7 were idle, and 31 abandoned. On the South Dome 1 was producing, with 6 abandoned.

The small Carbonera field has 2 wells giving about 30 brl each per day. Tibu has

13 wells yielding Tertiary oil at the rate of about 200 brl/day. 7 Tertiary wells and 2 Cretaceous wells are shut in. At Rio de Oro 4 wells are abandoned and 9 shut in.

14 Tertiary producers have been completed on the northeastern part of the Socuavo structure in 1945.

Two deep Cretaceous tests are under way at Tibu. Stepouts in the Tibu structure have found the Tertiary sand development to be erratic. G. D. H.

**446. The Optimum Rate of Production.** P. J. Jones. Part 22. *Oil Gas J.*, 26.1.46, **44** (38), 289.—Rates of production proportional to reserve are uniform rates of depletion. The rate of production decline is uniform and equal to the rate of depletion. The initial rate of production is numerically equal to the rate of depletion. The optimum rate of production is the initial rate of production for which the rate of depletion is optimum. In terms of production decline, the optimum rate of production for the reserve recoverable at uniform rates of depletion is the initial rate of production for which the rate of production decline is optimum. Operating expenses usually increase as rates of production decline. So optimum initial rates of production are expressed in terms of average operating expenses that are equivalent to the increasing expenses which usually accompany declining rates of production. These considerations are illustrated graphically and by examples. A. H. N.

**447. The Optimum Rate of Production.** Part 23. P. J. Jones. *Oil Gas J.*, 2.2.46, **44** (39), 72.—The optimum rate of production is slower for uniform than for declining rates of production. If a fraction of a reserve is recoverable at uniform rates of production and a fraction at declining rates of production, the optimum rate of production is some value between the optima for uniform and declining producing rates. The optimum rate of production also varies with the rate of production decline. This article is limited to declining rates of production for uniform rates of depletion. A procedure is illustrated for estimating the optimum rate of production for any combination of fractional reserves recoverable at uniform rates of production and depletion. A. H. N.

**448. The Optimum Rate of Production.** Part 25. P. J. Jones. *Oil Gas J.*, 16.2.46, **44** (41), 94.—The optimum investment in a reservoir and the optimum present value of a reserve area are reviewed in this final article of the series. The data are relative to a given producing and operating method. But the size of a reserve for a given reservoir may vary significantly with producing and operating methods. Investments and operating expenses also vary with producing and operating methods. This brings us to optimum producing and operating methods. The problem of selecting the optimum producing and operating method for a reservoir may be more significant than that of estimating the optimum rate of production for a given producing and operating method. On the other hand, from the viewpoint of individual leases and migration of hydrocarbons in reservoirs, producing and operating methods are probably always more significant than the optimum rate of production.

However, the optimum rate of production is the background on which estimates of optimum producing and operating methods are made for reservoirs and for leases. This is why optimum producing and operating methods in the order of presenting these series on the production of oil, condensate, and natural gas. A. H. N.

**449. Reservoir Engineering in 1945.** M. Muskat. *Petrol. Engr*, Jan. 1946, **17** (4), 51–54.—A review of the technical achievements in reservoir engineering made in 1945 and of the important papers which appeared in the press is presented. 41 references to important papers are given. A. H. N.

**450. Running Instruments in Annulus of Tubed Wells.** C. C. Olson. *Oil Wkly*, 4.3.46, **121** (1), 33–34.—In pumping wells time and labour can be saved when making subsurface pressure studies if an annulus head is installed so that instruments can be lowered without pulling the well. In order to reduce the down time, and also to eliminate the use of the pulling unit and crew, 100 wells were equipped with annulus-type tubing heads. In these key wells 180 runs were made. The instrument fouled

around the tubing, preventing its removal 33 times. This required the use of the pulling unit and crew to raise the head in order to free the instrument. In order to eliminate the use of the pulling unit and crew, a hydraulic lifting device was designed and constructed, and the instrument was then removed in approximately 1 hour by two men. The use of the annulus head and the portable lift equipment saved 8 crew hours on each pressure measurement. The development of the well-head and the use of the system are detailed. A. H. N.

**451. Impact of Wartime Conditions on the Petroleum Producing Industry.** L. C. Uren. *Petrol. Engr*, Jan. 1946, **17** (4), 203.—Professor Uren discusses briefly the significance of recent advances to the oil industry. In his view, for instance, there is nothing in present knowledge of nuclear physics to justify the idea that energy from this source will seriously influence the demand for petroleum products, within the foreseeable future. However, advances in the electronic field have contributed to the analytical side of the industry in large measures. Briefly these advances, as well as those made in synthetical operations, metallurgy, and radioactivity logging, are reviewed. A. H. N.

**452. Oil Reservoir Energy—Analyzing Its Source.** K. M. Fagin. *Petrol. Engr*, Jan. 1946, **17** (4), 218.—The mechanisms of water, gas-cap, and dissolved gas-drives are described. The simultaneous functioning of all three drives in producing oil from a reservoir is explained. A table gives the main characteristics of reservoirs under the different types of drives. A. H. N.

**453. The Electrolytic Model and Its Application to the Study of Recovery Problems.** H. G. Botset. *Petrol. Tech.* (*A.I.M.M.E.*), Nov. 1945, **8** (6); *Tech. Pub. No.* 1945, 1–10.—Electrolytic models allow the simulation of water-flooding and gas-recycling systems, as well as the encroachment of a natural water-drive. In a few days, and at a negligible cost, it is possible to obtain qualitative and roughly quantitative data on the effects on recovery of variation in the distribution and rates of operation of input and output wells in a given field.

The results from these model experiments represent highly idealized conditions practically never found in actual field operations. Nevertheless, the pictures obtained in experiments on a given field, when considered in conjunction with the variations in porosity, permeability, sand thickness, etc., afford information obtainable in no other way, and should aid in planning a better operating technique.

The principles of operation and the apparatus are described in some detail, together with the method of operation and the limitation of the electrolytic model technique. G. D. H.

**454. A New Technique for Determining the Porosity of Drill Cuttings.** M. A. Westbrook and J. F. Redmond. *Petrol. Tech.* (*A.I.M.M.E.*), Nov. 1945, **8** (6); *Tech. Pub. No.* 1943, 1–4.—Cores are not always available for porosity studies, and therefore a method employing drill cuttings is of considerable value. The cuttings are washed, and extracted, after which a weighed quantity is saturated with water in a graduated vessel in order to determine the volume of the grains. The bulk volume of the cuttings is obtained by removing excess water by suction on a porous plate, after which the volume they displaced is measured.

Low-permeability cuttings may present difficulties.

The cuttings analyzed should be representative of the interval under study. They should be picked free of shale, and should be as large as possible. In zones of special interest it may be necessary to drill only about 2 ft and circulate all cuttings out of the well before drilling. Reverse circulation may be helpful in giving large cuttings without much mixing. G. D. H.

**455. Predictions of Behaviour in Air–Gas Drive.** R. J. Day and S. T. Yuster. *Oil Wkly*, 18.2.46, **120** (12), 18.—A linear function is shown to exist between liquid saturation of long cores, under air drive in the laboratory, and the logarithm of the volume of air necessary to reach that saturation. The equation so obtained for laboratory performance is used as a basis for the derivation of an equation describing field behaviour under constant rate of air injection. The field equation states that the reciprocal of

the oil-production rate is a linear function of the elapsed time. The validity of the field equation was verified by the use of data from five leases. Fair correlation was obtained between the constants of the equation for the field relationship with the corresponding constants for the laboratory relationship. An equation for the accumulative oil production in the field is derived, which states that the production over a given period of time is proportional to the logarithm of the ratio of the initial and final oil-production rates. Agreement was obtained between actual production and that calculated by use of this equation. A. H. N.

**456. Precision in Bottom-Hole Pressure Measurement.** E. R. Brownscombe and D. R. Conlon. *Petrol. Tech.* (*A.I.M.M.E.*), Nov. 1945, **8** (6); *Tech. Pub. No.* 1942, 1–14.—Reservoir-pressure measurements involve gauge errors and interpretation errors. The former errors may be reduced by: (1) reading the charts with a comparator microscope; (2) using a stylus point with a special noble-metal tip, drawing on copper charts with uniformly heavy coatings, to give fine, clear lines; (3) ensuring temperature equilibrium; (4) making multiple tests. Check calibrations are quite as important as check well tests. A statistical study of such check tests shows the advantages of a standardized "zero pressure line," and of the making of field calibrations at bottom-hole temperature and their recording on the same chart as the well run.

Interpretation errors may be reduced by correcting fluid-heads to the top of the perforations on the basis of well-fluid gravity, and correcting from the top of the perforations to the datum level on the basis of reservoir fluid gravity. Allowance should also be made for the pressure gradients around the well. Conventional shut-in periods may be quite inadequate to eliminate the pressure gradients, and it may be necessary to make reservoir studies based on build-up curve data, reservoir history, core analysis, and any other available information.

When pressure data of high accuracy are available it is possible to employ them in such matters as reserve estimates at an earlier date than is otherwise practicable.

G. D. H.

**457. Effect of Reservoir Fluid and Rock Characteristics on Production Histories of Gas-Drive Reservoirs.** M. Muskat and M. O. Taylor. *Petrol. Tech.* (*A.I.M.M.E.*), Sept. 1945, **8** (5); *Tech. Pub. No.* 1917, 1–16.—Theoretical investigations have been made on the performance to be expected of gas-drive reservoirs for various characteristics of the oil and gas and the producing rock. Such performance has been expressed graphically as curves for the reservoir pressure and gas–oil ratios of the production as functions of the cumulative oil recovery. The latter has been expressed in terms of percentage of pore space of the reservoir rock. Such curves automatically give values for the ultimate physical recovery, if the latter is interpreted as the recovery obtained when the reservoir pressure has declined to atmospheric or to any other pressure chosen as defining the state of practical complete depletion.

Calculations of these pressure and gas–oil ratio histories have been made for conditions in which the oil viscosity, the gas solubility and shrinkage, the size of the overlying gas cap, if present, the permeability-saturation characteristics of the rock, and the amount of connate water, have been separately varied. The results show the extent to which the ultimate recoveries are sensitive to the important physical parameters characterizing the oil reservoir.

The ultimate recoveries were found to decrease with increasing oil viscosity. Because of the predominating effect of oil shrinkage associated with the liberation of gas from solution, the ultimate recovery decreased with increased gas solubility. Increasing the gas-cap volumes led to higher recoveries, although the contribution made by the gas-cap was small as compared with the oil expulsion by an equivalent amount of solution gas.

On the whole, the oil recovery when expressed as a percentage of the pore space was not very sensitive to the details of the permeability–saturation relationship. However, if the rocks possess an equilibrium free-gas saturation the rise in gas–oil ratio will be retarded, and the ultimate recovery increased.

The oil shrinkage associated with the liberation of dissolved gas leads to the result that so long as the connate water is immobile and the permeability ratio curve for the rock is a function only of the total liquid saturation, the stock-tank oil recovery will

be less for a sand containing no connate water than for one with an original water content as high as 30%. The space voidage in the former case will be rather greater, but the effect of oil shrinkage will lead to smaller values for the equivalent stock-tank recovery.

Curves are given showing the variation of the productivity indexes of wells during the reservoir history. Because of decreasing permeability to oil and increasing oil viscosity, the productivity index will fall continuously as production proceeds, and may ultimately reach values as low as 10% of the initial productivity index.

G. D. H.

**458. Investigation of Factors that Affect Fluid Flow in Porous Media.** R. Sneddon. *Petrol. Engr*, Jan. 1946, **17** (4), 55–56.—Details of core analysis for grain-size, porosity, and permeability are presented. The use of such test results in the study of factors affecting underground flow of fluids is given in a brief, qualitative discussion.

A. H. N.

**459. General Value of Input and Producing Records in Secondary Recovery.** Anon. *Oil Wkly*, 4.3.46, **121** (1), 26–28.—The thesis of the paper is that study and control of volumes and pressures at the input well is a more definite and an easier way of controlling production from a pool than control or remedy at the outlet wells. Graphs for volumes v. pressure for normal and for channelling production are given. On injection of water or gas, there is a time lag after which an increase in production ensues. Following this first increase, the danger point in a normal repressuring project is present due to the possibility of input gas channelling to a producer and not establishing an oil-moving pressure gradient. Periodic gas–oil ratio tests will reveal channelling of input gas if a sudden and large increase is noticed in produced gas volumes. If channelling takes place, the producer affected usually shows an increase in both oil and gas production at first, followed by a decrease in oil production and an increase in gas production. The increase in gas production will depend on the completeness of the channelling as well as input gas volumes. It has been found that corrective measures applied to producing wells to prevent or stop channelling, such as holding back pressure on the well or raising the fluid level in the same, does retard gas movement through the channelled section, but also decreases or completely stops oil production, due to the increased back pressure applied to the producing well bore. It is being generally accepted that any corrective measures to control channelling should therefore be applied to the input well. Different cases are discussed. A. H. N.

**460. Oil and Gas Reserve Estimation Charts.** D. G. Barnett. *Oil Wkly*, 4.3.46, **121** (1), 22–24.—The charts can be used for estimating reserves from the four primary factors: productive area, average thickness of sand, effective porosity which is the gross porosity minus the allowance for connate water, and the pressure under which gas exists, commonly taken as the well-head shut-in pressure. A. H. N.

**461. Some Practical Aspects of Radioactivity Well Logging.** W. J. Jackson and J. L. P. Campbell. *Petrol. Tech.* (*A.I.M.M.E.*), Sept. 1945, **8** (5); *Tech. Pub. No.* 1923, 1–27.—The principles and equipment employed in gamma-ray logging and in neutron logging are briefly described. Both can be employed in cased holes. Limestones and sandstones give minima on the gamma-ray curves. In neutron logging formations containing hydrogen-bearing substances, such as the fluids commonly found in the rock pores, give lower intensities than those which are denser and so contain less fluid. In this way a minimum on the neutron curve would indicate sandstone, and a maximum might indicate a dense limestone.

A series of examples of the application of radioactivity well logging are given. These include the following: selection of water shut-off; determination of formations in old wells with incomplete logs; location of formations for salt-water disposal; detection of water-bearing beds in old wells; location of porous zones in limestones; location of oil and gas zones; permeability studies by means of pumping in fluid with a radioactive tracer; determination of cement emplacement by carnotite in the cement; detection of direction of travel of cement in squeeze cementing; geological correlation; logging in salt-water muds and in oil-base muds; logging when difficult conditions such as

high pressures have required the running of casing without an electrical log being made; location of casing seats; clarification of doubtful data.

An experimental electrical collar locator has been devised to record the position of casing collars on the gamma-ray logs. G. D. H.

**461A. The Wire-Line Tubing Perforator and its Use to Complete Wells for Gas Lift in the Gulf Coast Area.** J. O. Farmer. *Petrol. Tech.* (*A.I.M.M.E.*), Sept. 1945, **8** (5); *Tech. Pub. No.* 1881, 1–12.—The wire-line tubing perforator is a mechanically operated tool that is run on an ordinary steel measuring line into the tubing of a well, under pressure, to drive into the wall of the tubing, and securely lock in place, a tapered, cylindrical insert containing an orifice. Use of the perforator obviates the necessity of pulling and re-running the tubing to instal jet collars or flow-valves, reduces the cost, and simplifies the task of placing an oil-well on gas-lift operation. Of more importance is the use of the tool with a removable check valve and stop, to provide a means of washing drilling mud from the annulus between the tubing and casing, and to complete the well for gas-lift operation without exposing the producing formation to the mud column and without moving the tubing-string.

The origin, development, and mechanics of the wire-line perforator are discussed, together with the various purposes for which the tool was designed and the method of selecting orifice sizes for any depth, and the results obtained thus far in practical operation are given. G. D. H.

**462. Salt Water Disposal Problems.** O. S. Jones. *Oil Wkly*, 28.1.46, **120** (9), 34.—The chemical constituents of oilfield brines are discussed. It is suggested that for those brines containing large amounts of magnesium, the recovery of the metal may pay for the whole disposal unit.

An interesting historical development of the practices of salt-water disposal from the early times of the industry up to date is presented. After a period of unchecked disposal into creeks and streams, ponds were used, but these were found ineffective, due to underground seepages and contamination. A. H. N.

**463. Subsurface Brine Disposal.** O. S. Jones. *Oil Wkly*, 4.2.46, **120** (10), 27.—This paper is a continuation of the paper abstracted above (No. 462). Shallow horizons—*i.e.*, down to 1000 ft below ground—have not proved successful brine-disposal reservoirs in all circumstances. After a brief discussion of the advantages of deep-disposal sands, the structure of brine-disposal associations and their development are given in brief. The use of brines for secondary recovery has been successful in several projects. Legislation against pollution of fresh water and of land for cultivation is briefly discussed. A. H. N.

**464. The Engineering of Oil-Well Abandonments.** W. E. Schoeneck. *Petrol. Tech.* (*A.I.M.M.E.*), Nov. 1945, **8** (6); *Tech. Pub. No.* 1946, 1–12.—The circumstances which lead to the abandonment of producing wells are worthy of study.

All available data on the drilling, testing, and completion of a well should be studied, together with its production history. The production trend may be deduced from curves, and by examining the results of acidizing, the possible effects of further acid treatment may be predicted. Maps showing features such as oil and water production, water encroachment, gas–oil ratios, and types of equipment are valuable.

After analyzing the data it is necessary to consider whether any treatment will provide sufficient increase in production to merit its application. Efforts may be made to reduce gas–oil ratios and water production, to increase the reservoir permeability by acid treatment, to remove clogging materials, or to raise the efficiency of lifting equipment. Production from other horizons may be considered, as well as the possibilities of secondary recovery. Costs must be examined, and salvage values taken into account.

If all the pertinent factors are properly considered, it is believed that there will be greater accuracy in the determination of non-profitable wells, and conversely production may be continued in wells which otherwise would be abandoned prematurely.

G. D. H.

## Oilfield Development.

**465. Clay Research and Oil-Development Problems.** J. C. Griffiths. *J. Inst. Petrol.*, Jan. 1946, **32** (265), 18–31.—The significance of the physical and chemical properties of various types of clay in the evaluation and development of oil reservoirs is outlined. A plea for a greater amount of research and study of reservoir rock petrology and mineralogy is made. A. H. N.

# Transport and Storage.

**466. Graphic Solutions of Design Problems. 1. Fluid Flow in Pipes.** P. Buthod and B. W. Whiteley. *Oil Gas J.*, 20.10.45, **44** (24), 122.—The first of a series of twelve articles on the solution of fluid-flow problems.

Fluid flow involves all energy effects which in practice must be known in order to state power requirements, discharge rates, and other design information. For incompressible fluids and isothermal conditions this can be stated in the form of an energy equation, while for compressible fluids when heat effects are involved this equation is expressed in a different form, involving thermodynamic functions. It may be shown that for Reynolds number (a function of density and viscosity) under 2000 viscous flow is obtained, while above a Reynolds number of 3000 or 4000 the fluid motion becomes turbulent. The importance of the Reynolds number lies in that, knowing this, the friction factor may be readily determined, permitting reliable prediction of pressure loss, discharge rates, etc., for flow of liquids or gases of widely varying viscosities and densities.

Modes of expressing Reynolds numbers, and its determination for particular flow conditions by means of a chart (which is included) are given. T. M. B. M.

**467. Design of Structural Details for High Towers.** J. Yeakel. *Refiner*, Dec. 1945, **24** (12), 513–514.—The principles of designing anchor-bolts and ring-plates are detailed, and an example illustrates the method. A. H. N.

# Refinery Operations.

## Refineries and Auxiliary Refinery Plant.

**468. The Refiner's Notebook, Temperature Difference in Exchangers.** Anon. *Oil Gas J.*, 22.12.45, **44** (33), 91.—The theory of heat exchangers is discussed, together with factors which determine their efficiency, and examples of typical calculations are given. The rules given introduce an error of less than 4½%, which is considered to be far less than errors introduced by lack of knowledge of transfer rate and other uncertainties. T. M. B. M.

**469. Peacetime Utility of Wartime Petroleum Refining Processes.** F. D. Parker. *Petrol. Engr*, Dec. 1945, **17** (3), 116.—A statistical report indicating the task performed by the U.S. refining industry during the war years and the size of the problem of reconverting it to peace-time demands. T. M. B. M.

**470. Cost Accounting in Refinery Construction.** R. C. Lewis. *Refiner*, Jan. 1946, **25** (1), 30–35.—The advantages of keeping accurate and detailed cost accounts are given, followed by a description of the different cost codes which are used: those adopted by the U.S. Army Corps of Engineers, Aberthaw Co., and Morton C. Tuttle Co. of Boston, Massachussetts, and E. B. Badger & Sons Co., Boston. The application of the different codes is described. A. H. N.

**471. New Refinery Construction under way and Projected in Venezuela.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 273.—Turiamo, situated on Turiamo Bay (20 km. east of Puerto Cabello) has been selected by Creole for their new 40,000-brl refinery. This will cost about $50,000,000, and will produce aviation and motor gasoline, kerosine,

industrial, automotive and marine diesel oils, lubricating oils of all types, greases, industrial and marine bunker fuels, and asphalts.

In addition to the 38,000 brl/day refinery of the Shell Group at San Lorenzo, Lake Maracaibo, a new refinery near Punta Cardon (Paraguana Peninsula) is planned. This plant will have a capacity in excess of 40,000 brl, and will be owned and operated by the Shell Co. of Venezuela. The cost is expected to be in excess of $45,000,000.

The Compania Consolidada de Petroleo has also made plans for the construction of a 35,000-brl refinery. T. M. B. M.

**472. Germany's Progress in Straight Refining is Reported Inferior to U.S. Advances.** W. F. Bland. *Nat. Petrol. News*, 3.10.45, **37** (4), R763.—During the war, German methods of straight refining and production of high-quality products were far less efficient than those used by the Allies, but technological progress in synthetic fuels and lubricants was much more rapid.

The octane ratings of both their motor and aviation fuels were considerably less than the standard 80 and 100 octane used by the Allies. Synthetic production of petroleum products increased rapidly during the war from about one-third of total consumption to over 60% in 1944 (crude petroleum being the source of only 40%). At this peak aviation gasoline production was still less than 10% of that of the Allies (500,000 brl/day).

Two grades of aviation gasoline were produced, bomber and fighter, both comparable to our own on rich mixture, but about 91 and 95 octane respectively on lean rating. Modified engine design gave service on these fuels comparable with results obtained on our own. A fuel of rating less than 80 was used for ground transport.

Although the Germans had done a great deal of work on catalytic cracking, they never had any actual production units in operation, probably owing to their existing coal hydrogenation and reforming processes. Also they were limited in the supply of crude oil. Their aviation base stock was blended with small amounts of alkylate, and *iso*pentane and T.E.L. was used to the extent of 4–5 cc/gal. Nothing was developed superior to T.E.L.

Two gasoline additives were developed to prevent corrosion due to water injection, these were: (*a*) Dodecylphenyl chloride condensed with glycine (*cyclo*hexylamine salt); and (*b*) *iso*Butyl *cyclo*hexyl butyric acid (*cyclo*hexylamine salt).

Poly*iso*butylene was used to improve the viscosity of lubricating oils, and poly-vinyloleyl ether and its copolymers with vinyl *iso*butyl ether were used as pour-point depressants.

A concerted effort by the Germans to move their refineries underground was made, but fewer than ten were actually in underground operation, with many more in various phases of completion. This did not include hydrogenation equipment, owing probably to the tremendous pressures frequently used and the risks inherent in mechanical failure and subsequent explosion.

The methods to be employed by the United States in disseminating technical information as to German refining and production methods are given. T. M. B. M.

**473. Improved Operating Techniques in Refining will Accrue from Atomic Bomb Research.** Anon. *Nat. Petrol. News*, 3.10.45, **37** (40), R836.—Among the peacetime technological advances from atomic bomb research which are important to petroleum refiners are the following: (*a*) *Corrosion prevention*. New methods have been worked out for pretreating metals to be resistant to highly reactive compounds such as uranium hexafluoride; (*b*) *Pumps*. A significant advance in pump design provides for utilization of supersonic velocities; (*c*) *Barriers for gas diffusion*. The new techniques worked out for diffusional separation may be used for isolating hydrogen from process gases and ethylene from cracked gas oil; (*d*) *Instruments*. New types of precise, continuous automatic analytical control instruments should become available to the industry; (*e*) *Leak detector*. The application of a highly sensitive leak detector which was used to locate leaks in high-vacuum plant, checking equipment, and testing welds is foreseen; (*f*) *Heat exchangers*.

A new type of mass spectroscope developed at Oak Ridge is believed to be applicable to the control of cracking operations and transfer-line analysis, as well as accurate analysis of natural gas, continuous automatic control of gaseous processes such as alkylation, dehydrogenation, and vapour-phase cracking. T. M. B. M.

## Distillation.

**474. Compression Distillation.** A. Latham, Jr. *Refiner*, Dec. 1945, **24** (12), 515–518.—*Paper presented before American Society of Mechanical Engineers.* Compression distillation depends on mechanically compressing the steam or other vapour leaving the evaporation compartment of the still. This compression raises the temperature of the steam a few degrees. At the higher pressure the steam condenses at a temperature somewhat higher than the boiling point of the evaporating raw water, so that heat can flow from the condensing steam to the raw water and boil it. In engineering terms, the condensing vapour is used to supply heat inside the steam-chest of the still in place of steam from sources outside the unit. Efficient provision for reducing heat loss to the atmosphere and recovering heat from the distillate and the concentrate carrying out waste as they cool down to room temperature completes the system. No separate condenser or cooling water is needed. The overall fuel economy of the most recent Kleinschmidt compression stills—averaging at least 175 lb of distillate for each lb of fuel consumed—is believed to be the highest of any self-contained system of evaporation.

A. H. N.

**475. Commercial Synthesis of Toluene by Hydroforming, and Recovery by Azeotropic Distillation.** F. L. Hartley. *Refiner*, Dec. 1945, **24** (12), 519.—*Paper presented before California Natural Gasoline Association.* The elements of hydrocarbon chemistry and of hydroforming are outlined, followed by a brief discussion of the isolation and purification of toluene of nitration grade by means of azeotropic distillation.

A. H. N.

**476. The Refiner's Notebook. Number of Fractionating Trays.** *Oil Gas J.*, 6.10.45, **44** (22), 117.—The measurement of fractionation by means of the gap or overlap of the distillation ranges of the products is described. Using A.S.T.M. distillation temperatures, the gap or overlap of the temperature of the 95% point of the low-boiling product and the 5% temperature of the high-boiling product are compared, and tables showing the relation between these and the number of theoretical plates at various reflux ratios are given.

T. M. B. M.

**477. High Recovery, Superfractionation Mark Superior's Lake Creek Operations.** A. L. Foster, *Oil Gas J.*, 2.2.46, **44** (39), 50.—A description of the Superior Oil Co's Lake Creek plant for gasoline recovery from wet cycle gas. The plant is designed to treat 58 million cu ft of gas containing 6·5 gal/1000 cu ft of $C_3$'s and heavier. It is said to be capable to recovering 65,000 gal/day of propane, 43,000 gal of *iso*butane, 65,000 gal of *n*-butane and 30,000 gal of *iso*pentanes and should yield 150,000 gal of *iso*butane and *iso*pentane-free natural gasoline along with a 2500-brl/day capacity for stabilized distillate. The range of the latter product includes gas oil and yields kerosine and motor gasoline.

The plant is similar in general operation to others of its kind, but embodies several distinctive features such as the following: (*a*) propane refrigeration system, controlling the gas and oil temperature, an important factor in ensuring good propane and heavier recovery; (*b*) automatic gas injection temperature control; (*c*) automatic booster compressors (two 225-h.p. Ingersoll Rand units increasing discharge pressure on any desired proportion of the injection gas from 4100 to 4900 lb/sq in); (*d*) automatic speed and pressure control of compressor engines; (*e*) automatic temperature shut-down device on compressor cylinder-packing glands to guard against rise above normal operating temperature.

A vapour-recovery system whereby all tank vehicles are loaded under slight pressure, the vapours being collected and returned to the plant, is employed, and is responsible for approximately 1% of production.

All plant processes are discussed in detail and a flow-sheet is included.

T. M. B. M.

**478. No Peace for Fractionators.** P. J. Harrington, B. L. Bragg III, and C. O. Rhys, Jr. *Refiner*, Dec. 1945, **24** (12), 502–506.—*Paper presented before American Petroleum Institute.* The war has increased the amount of engineering research in the petroleum industry to improve the efficiency and capacity of refinery process unit operation

equipment, such as fractionating towers, furnaces, heat exchangers, mixers and separators, compressors, and pumps. Examples of how this problem was approached in one company on one type of operation during the war are given. Minor changes in the internal structure of towers of representative pre-war design increased atmospheric crude pipe-still throughputs from less than 30,000 brl capacity to 40,000–50,000 brl, with excellent separating efficiency while representative light ends fractionators for separating iso- and normal butane were increased in limiting vapour loads from 20,000 to 45,000 brl at over 100% efficiency. Through the Technical Advisory Committee of the Petroleum Industry War Council, and through the Petroleum Administration for War, the findings have been made available during the war to assist the industry in its war work. Extension of this type of engineering research is recommended. A. H. N.

## Cracking.

**479. Vapour Phase Oxidising Cracking of Oil Products.** L. J. Berents and V. E. Glushner. *Nat. Petrol. News* (*Tech. Sec.*), 7.11.45, **37** (45), R912.—An experimental study has been made of the vapour-phase cracking of oil products in the presence of oxygen with particular attention to the influence of temperature, reaction time, and concentration of oxygen.

The charging stocks included a gasoline fraction, a cracked kerosine, gas oil, and mazut, and the cracking experiments were performed in iron reaction tubes heated in ordinary laboratory furnaces.

Examination of both liquid and gaseous reaction products was carried out and compositions determined.

Results indicated that the presence of oxygen increased the velocity of reaction at temperatures not exceeding 700–720° C reaction velocity increasing with oxygen concentration. With the gasoline portion such cracking can be described by the equation for a first order reaction.

It is claimed that by oxidizing cracking a high percentage conversion and increased yields of aromatics can be achieved at temperatures lower than those required in ordinary cracking. D. L. S.

**480. Simplified Catalytic Cracking Unit Meets Requirements of Smaller Refiners.** N. K. Anderson and M. J. Sterba. *Oil Gas J.*, 22.12.45, **44** (33), 77; *Petrol. Engr*, Dec. 1945, **17** (3), 62; *Refiner*, Dec. 1945, **24** (12), 497–501.—A smaller capacity cracking unit has been designed for the use of the refinery of relatively small throughput, the details being based on experience in building and operating wartime fluid units. The plant operates at temperatures of from 800° to 1000° F on stocks ranging from naphthas to topped crudes, fed to the catalyst section without pre-flashing. Mechanical design is simplified greatly by placing the regenerator immediately above the reactor, in the same column. The microspherical form of catalyst is used in the new adaptation of the fluid process. Yields of 45–53% of gasoline are obtained, with octane ratings of 79–82 (A.S.T.M.).

Operating costs vary from 23·8 c/brl of charge for a 4500-brl unit with natural catalyst to 44·0 c/brl of charge for a 900 brl/day unit with silica–magnesia or silica–alumina synthetic catalyst.

Photographs, flow-sheets, and full details as to operating costs are included.
T. M. B. M.

## Isomerization.

**481. Fundamentals of Isomerization for Operators.** J. S. Finger. *Refiner*, Jan. 1946, **25** (1), 17–22.—The elementary chemistry of paraffin hydrocarbon is presented together with practical remarks on the running of isomerization plants, general types of units available, and pertinent warnings against corrosion hazards with aluminium and hydrogen chlorides and their mixtures. A. H. N.

**482. Thoria–Alumina Catalyst Best for *iso*Paraffin Synthesis.** Anon. *Oil Gas J.*, 19.1.45, **44** (37), 86.—A review of Technical Report No. 110–45 (U.S. Navy Office of

Research and Inventions) on research carried out at the Kaiser Wilhelm Institute in Germany on catalysts used in Fischer–Tropsch *iso*paraffin syntheses.

Thoria–alumina catalyst, in which the components are present in 1 : 4 weight ratio, is shown to be the most efficient discovered in Germany, being superior to zinc oxide, although more expensive. Higher gas velocities may be used, and alcohol formation tendencies are slight. Varying the $Al_2O_3$ content of the catalyst between 20% and 40% makes little difference, but further increase gives higher methane formation. Methods of preparing the catalyst are given.

Pressures of 300 atm and temperatures of from 420° to 450° C were found the best conditions for the formation of *iso*paraffins from carbon monoxide and hydrogen. The yield drops rapidly below this pressure, but increasing pressure gives a greater proportion of oxygen-containing compounds. Temperatures below 450° C show increases of alcohol and unsaturated materials, but with increasing temperature the products become mainly naphthenic. T. M. B. M.

## Chemical and Physical Refining.

**483. Regeneration of Caustic Solutions for Gasoline Treating by Catalytic Air Oxidation.** D. C. Bond. *Oil Gas J.*, 8.12.45, **44** (31), 33.—A description of the Mercapsol process of mercaptan sulphur removal from gasoline (as against the conversion of mercaptans to disulphides) which depends on air-blowing in the presence of an efficient catalyst composed of an inexpensive wood-tar fraction. The spent mercapsol solution can be regenerated by air-blowing, or steam if mercaptan sulphur concentration is above 0·02%.

A laboratory procedure for testing the efficiency of catalysts for oxidation using *n*-butyl mercaptan in caustic soda solution is given, and the results obtained with a number of catalysts tabulated.

The theory of the rôle of the catalyst in the oxidation of mercaptans is discussed, and the conclusion is reached that catalysts which are suitable for sweetening by oxidation of mercaptans and regeneration by air must be such as to form quinones when oxidized, and the hydroquinones upon reduction.

A flow diagram of a mercapsol–air regeneration unit is given. The gasoline to be treated is passed through a packed tower countercurrent to a mercapsol solution containing a small amount of wood-tar oxidation catalyst. Gasoline from the treating-tower is passed through a water washing-tower and a salt drying-tower. If the raw gasoline contains much hydrogen sulphide, it is given a caustic-soda wash prior to this treatment. Spent mercapsol solution is passed into a packed air-blowing tower kept at 100–120° F, from which it passed into a settling-tank when the small amount of gasoline separates, washing out a large part of the disulphides formed during regeneration. The settled catalyst solution then passes through a gasoline wash, when disulphides are removed more completely, yielding the completely regenerated solution.

The results of tests on representative samples of gasoline treated by this catalyst are given, as well as costs of catalyst, steam, air and equipment, and details as to gasoline loss. A list of references to the literature is appended. T. M. B. M.

## Special Processes.

**484. Fischer–Tropsch and Hydrogenation Plants in Ruhr Valley, Studied by Joint Mission.** Anon. *Nat. Petrol. News* (*Tech. Sect.*), 7.11.45, **37** (45), R861.—C.I.O.S. Report (Index No. 17), *Investigation of Ruhr Synthetic Oil Plants*, is an account of a visit made by a combined group of British and American petroleum technologists to ten Ruhr plants in April 1945.

Seven Fischer–Tropsch plants were visited, and particular interest was shown in the medium-pressure catalyst ovens, which consisted of a nest of pairs of vertical tubes one inside the other with the catalyst in the annular space. The ordinary Co–Th–Mg–kieselguhr catalyst was apparently used, although an Fe catalyst was being considered for a new projected plant.

Three hydrogenation plants were examined, and it was concluded that in coal hydrogenation little that was new or different from British practice had been developed.

A process (D.H.D. operation) for preparing aromatic gasoline by hydrogenating naphthenes was studied, but no information on the catalyst used is given.

The report concludes that scientific developments in these fields during the war were not very impressive, due perhaps to the need for concentrating on maximum production rather than on new methods and processes. D. L. S.

**485. Synthetic Lubricants Made at Two Plants in France.** R. C. Aldrich. *Nat. Petrol. News* (*Tech. Sect.*), 7.11.45, **37** (45), R859.—T.I.I.C. Report (Index No. 365) *Synthetic Lubricating Oil Production in France* describes two French plants producing synthetic lubricating oils—a pilot plant operating a German process at Harnes (Lille), and a plant producing 25 tons products per day, using a French process and operating at Lestaque (Marseille). Both plants use a Fischer–Tropsch oil as the basic raw material.

The pilot plant uses a gasoline cut which is reacted with 3% aluminium chloride in a revolving cylindrical drum.

The oils produced are not of first-class quality, and tend to oxidize readily.

The Marseille plant uses a paraffinous Fischer–Tropsch gas oil, benzol, and dichlorethane as raw materials. The gas oil is chlorinated in a series of lead-lined tanks, while the benzol and dichlorethane are mixed in the presence of aluminium chloride in a mechanically stirred tank. The two products are then mixed, and the resulting liquid stripped of uncombined benzol.

Two grades of oil are produced by this process—a general machine lubricant of medium quality, and a high-quality product of K.V.I. 100 and claimed to consist of a polybenzene with a long saturated paraffin chain. D. L. S.

**486. Acetylene Production by Electric Arc Cracking and Its Purification.** Anon. *Nat. Petrol. News* (*Tech. Sect.*), 7.11.45, **37** (45), R866.—T.I.I.C. Report (Index No. 189), *Synthetic Rubber Plant Chemische Werke Huls*, describes the production of acetylene at Hüls synthetic rubber plant by the electric arc cracking of natural gas (methane) or by product gas from coal hydrogenation (methane/ethane), using direct current at 7000 v. Conversions per pass through the arc is approximately 50%.

The exit gas from the reaction tube is cooled to 150° C and sent to two cyclones in series, where 60–70% of the carbon black is knocked down. Water spraying and filtering removes the remainder of the carbon, and this is followed by counter-current washing with an aliphatic oil to remove higher-boiling constituents. Passage through iron oxide boxes removes sulphur. Further purification by low-temperature distillation, low-temperature condensation, and evaporation using liquid ammonia and scrubbing with a petroleum distillate yields a 97–98% pure product. D. L. S.

**487. Arc Cracking of Gases Yields Acetylene for Butadiene in Hüls Rubber Plant.** Anon. *Nat. Petrol. News* (*Tech. Sect.*), 7.11.45, **37** (45), R865.—T.I.I.C. Report (Index No. 189), *Synthetic Rubber Plant Chemische Werke-Hüls*, is an account of a visit by a team of technologists to the Chemische Werke at Hüls in April 1945.

Buna S. type rubber was produced in this plant by polymerizing butadiene and styrene in a continuous process using six reactors in series. The butadiene was prepared from acetylene made at Hüls by the electric-arc cracking of methane and/or methane–ethane mixtures obtained essentially from nearby coal-hydrogenation plants. The acetylene was converted to acetaldehyde, which was in turn condensed to aldol. This was hydrogenated to butylene glycol, and subsequently dehydrated to butadiene.

Styrene was made by reacting benzene and ethylene in the presence of an aluminium chloride catalyst to form ethylbenzene, which was then dehydrogenated.

The plant had a rated capacity of 4000 tons/month, and made four types of Buna S, together with such by-products as carbon-black for tyres and diethylbenzene for blending in aviation gasoline. D. L. S.

**488. Patent Trends in Petroleum Refining.** P. J. Gaylor. *Nat. Petrol. News*, 3.10.45, **37** (40), R833.—*Direct Amination of Olefines.* The Sinclair Refining Co. have announced a process for producing amines and nitriles by reacting olefines with ammonia in presence of a catalyst (U.S. Patents 2,381,470–3 and 2,381,709). Previous processes of this kind are briefly referred to, and flow-sheets of Sinclair's processes, and a list of suitable catalysts, promoters, and supports are given.

In one example *n*-dodecene-1 is reacted with anhydrous ammonia in presence of an active unpromoted cobalt catalyst suspended on asbestos at a temperature of 500–550° F for 20 hrs at 2000 lb/sq in. 50–60% of the olefin is consumed under these conditions, and nitrogen compounds are produced to about 12% of the weight of the olefin charged (20–25% of the olefin consumed). The nitrogen compounds are mainly lauryl and dilauryl amine and lauronitrile, with possibly lauric acid amide. Little data are given for lower olefines. Diolefins: A method covered by du Pont (U.S. Patent 2,381,038) involves the continuous production of diolefines by pyrolysis of chlorinated hydrocarbons. Pyrolysis of 2 : 3-dichlorobutane at 650° C results in a yield of 0·8 mole 1 : 3 butadiene, 0·15 mole chlorbutadiene, and 1·75 mole HCl per mole of dichlorobutane introduced. A flow-sheet is included.

*Polysilicones from Petroleum.* U.S. Patents 2,258,218–22 disclosed the production of silicone polymers by reaction of ether solutions of phenyl and methyl magnesium bromides with silicon tetrachloride under reflux for several hours. The mixture is hydrolysed over cracked ice, and the silicols thus produced washed with water and partly condensed to silicones. The condensation and partial dehydration take place in toluene solution as the toluene is driven off, followed by subsequent heating to 175° C.

The Montclair Research Corp. recently combined 10 of its patent applications in Brit. Appl. 7382/45 covering the production of organo silicon compounds from hydrocarbon halides. Silicon hydride is reacted with Grignard reagent, and an alkyl or aryl halide in presence of magnesium or lithium at refluxing temperature.

A list of selected patents of the month are also included. T. M. B. M.

## Metering and Control.

**489. Maintenance of Mercury-Type Orifice Meters.** M. Welch. *Refiner*, Dec. 1945, **24** (12), 531–532.—This forms part of Southern California Meter Association Meter Course. A. H. N.

**490. Telemetering and Remote Control.** H. J. Keeling. *Refiner*, Jan. 1946, **25** (1), 40–41.—This paper is a reprint of a paper by the author which was presented in 1940 before the Southern California Meter Association, but it has been brought up to date. A. H. N.

**491. Fundamentals of Control Equipment.** C. Cortelyou. *Refiner*, Jan. 1946, **25** (1), 38–40.—This paper forms a part of Southern California Meter Association Meter Course. A. H. N.

## Safety Precautions.

**492. Safe Practice in Oxy-Acetylene Welding.** D. Attaway. *Refiner*, Dec. 1945, **24** (12), 493–496.—Safety rules are given for the generation and use of acetylene and oxy-acetylene welding and cutting. Safety precautions to be adopted with the use of the cylinders, hose, regulators, torches, and personal protection to be insisted upon are presented. A. H. N.

**493. Some Notable Wartime Oil Fires.** W. J. Wilmoth. *J. Inst. Petrol.*, Jan. 1946, **32** (265), 1–17.—Oil-fires which took place in Britain during the late war, and the practices adopted in fighting them are presented. A report of a discussion follows the paper. A. H. N.

# PRODUCTS.

## Chemistry and Physics.

**494. Method for Predicting Phase Equilibrium Constants.** C. G. Kirkbride. *Refiner*, Dec. 1945, **24** (12), 485–492.—An empirical method is presented for calculating the phase equilibrium constants of hydrocarbons, which appears to give results in some-

what better agreement with observed values than any previous method published. An empirical correlation for fugacity coefficient (fugacity divided by absolute pressure) has been developed which permits reasonably accurate predictions of phase equilibrium constants up to pressures of 2000–3000 psiA. The empirical fugacity coefficient is correlated with reduced pressure (absolute pressure of system divided by absolute critical pressure of component) and reduced temperature (absolute temperature of system divided by absolute critical temperature of component). The accuracy of the correlation has been checked against experimentally determined phase equilibrium constants for ethylene, ethane, propylene, propane, *iso*butane, *n*-pentane, benzene, *n*-heptane, toluene, *n*-octane, and *n*-decane. With the exception of *n*-decane, the predicted equilibrium relationships for all hydrocarbons investigated are in reasonably good agreement with experimental data reported in the literature by several investigators. Previous methods are evaluated, and are shown to be inferior in accuracy to the proposed method. A. H. N.

**495. Fundamentals of Consistency and Viscosity.** Part I. J. J. Bikerman. *Refiner*, Dec. 1945, **24** (12), 507–512.—The fundamental concepts involved in the rheology of ideal liquids (Newtonian fluids) and ideal (Hookian) solids are given. The principles of viscometry are very briefly explained, and finally Maxwell's ideas about relaxation times and interrelationship between viscosity, elasticity, and relaxation times are outlined. The behaviour of viscous liquids under suddenly applied stresses becomes understandable through these concepts, as these liquids shatter like solids due to the shortness of time allowed them in which to relax. A. H. N.

**496. Fundamentals of Consistency and Viscosity.** Part 2. J. J. Bikerman. *Refiner*, Jan. 1946, **25** (1), 23–29.—Non-Newtonian systems are discussed, and it is pointed out that there are a great number of ways in which a system may deviate from the "normal" or Newtonian behaviour. Thus it may not be possible to generalize the behaviour of all non-Newtonian systems, as is possible with Newtonian systems.

Plastic, pseudoplastic, and dilatant systems showing thixotropy or being independent of previous history are discussed. An important distinction is drawn between quartz suspension in water giving dilatant behaviour and, say, calcium naphthenate colloids showing similar behaviour, but probably due to a different mechanism. A. H. N.

**497. Experimental Determinations of Vapour-Liquid Equilibria Between Natural Gas and 95% Diethylene Glycol, up to a Pressure of 2000 lb/sq in.** G. F. Russell, L. S. Reid, and R. L. Huntington. *Refiner*, Dec. 1945, **24** (12), 525–529.—*Paper Reprinted from Transactions of the American Institute of Chemical Engineers.* This experimental study, which is related to the dehydration of natural gas by diethylene glycol, was undertaken because of the need for equilibria data in the design and operation of high-pressure absorption plants. In the laboratory a concurrent vapour liquid contactor was used for the dynamic mixing of natural gas with a glycol–water solution of known composition. The total water and glycol–vapour content of the natural gas was determined by sorption in anhydrous magnesium perchlorate, while separately the glycol vapour was absorbed in distilled water. The water–vapour content was calculated by difference. These equilibria data are presented as a ratio of the mol fraction of the component in the vapour phase to the corresponding mol fraction in the liquid solution. Both water and diethylene glycol equilibrium ratios exhibit minimum values at approximately 1500 psi, passing into the retrograde condensation range above this pressure. A rapid decrease in dehydration efficiency at pressures exceeding 2000 psi is indicated. A. H. N.

**498. Behaviour of Sodium Stearate with Cetane and Water.** R. D. Vold and J. M. Philipson. *J. Phys. Chem.*, 1946, **50**, 39–53.—The transition temperatures and solubility relationships of the binary system cetane–sodium stearate and the ternary system cetane–water–sodium stearate are presented, together with a description of the various phases, which are of a colloidal nature ranging through clear solutions of "solubilized oil" and emulsions to gels varying from transparent jellies to waxy solids.

The transition temperatures, determined by visual observation between crossed polaroids, were :

$T_i$, temperature of formation of a liquid isotropic to polarized light ;

$T_w$, temperature at which an opaque anisotropic gel becomes relatively clear ;

$T_g$, in the binary system, the temperature at which a gel melts sufficiently to flow, and is usually in the neighbourhood of $T_i$ or $T_w$ ;

$T_m$, in the ternary system, the temperature at which the translucent gel formed below $T_i$ becomes slightly opaque ;

$T_h$, in the ternary system, the temperature below $T_m$, at which the gel becomes densely opaque.

In the binary system homogeneity occurred between 30% and 60% soap ; below and above these limits free cetane and sodium stearate respectively separated out. With decreasing concentrations of sodium stearate both $T_i$ and $T_w$ decreased in a series of steps.

The ternary system was examined by adding increasing concentrations of sodium stearate to the two other components, which had the compositions 1 : 3, 1 : 1, 3 : 1 cetane : water. At low stearate concentration each mixture consisted of two phases, which became harder and less gel-like as the soap concentration was increased.

$T_i$ for the binary system contained two maxima, corresponding to the presence of superneat and middle soap. For the ternary system one maximum, corresponding to the formation of superneat soap, was obtained when the solvent composition was 1 : 3 and 1 : 1 cetane : water ; and a minimum occurred when the composition was 3 cetane : 1 water. In all three cases $T_h$ fell with decreasing concentration in an irregular manner.

Conclusions are : (1) the addition of water to the binary system diminishes the number of transitions undergone by the system ; (2) the effect of increasing the cetane content of the system, keeping the soap concentration constant, is to increase the temperature range of the resulting gels. Increasing the proportion of water promotes the formation of emulsions rather than gels at lower temperatures ; (3) $T_g$ does not represent a phase change, although the change is from anisotropic gel to liquid ; (4) syneresis at a given temperature depends partly on whether isotropic liquid is present as an equilibrium phase. H. C. E.

**499. Thermodynamic Properties of Propane and Butane.** Anon. *Oil Gas J.*, 2.2.46, **44** (39), 89.—The following properties of saturated propane and butane are given at 5° F intervals over the temperature range 0–100° F : (i) pressure in lb/sq in (absolute and gauge) ; (ii) specific volume in cu ft/lb for liquid and vapour ; (iii) density in lb/cu ft for liquid and vapour ; (iv) enthalpy in B.Th.U./lb for liquid and vapour ; (v) latent heat in B.Th.U./lb ; and (vi) entropy in B.Th.U./lb/° F for liquid and vapour.

(iv) and (vi) are referred to saturated liquid at −200° F where the values are zero. A general discussion together with definitions is included. T. M. B. M.

**500. Mechanism of Action of Organic Chlorine and Sulphur Compounds in Extreme-Pressure Lubrication.** C. F. Prutton, D. Turnbull, and G. Dlouhy. *J. Inst. Petrol.*, Feb. 1946, **32** (266), 90–117.—A detailed experimental and theoretical study of the subject leads to the following conclusions : (1) Reaction of organic sulphides with iron probably takes place by the following mechanism :

$$R_xS_x + Fe \rightarrow FeS + R_xSz_{x-1}.$$

It is not possible to ascertain from the present data whether or not there is splitting of the additive on the iron surface to give sulphur prior to reaction ; (2) Under mild or slowly applied loads, reaction of organic chlorine compounds with iron probably takes place as follows :

$$R_yCl_x + Fe \rightarrow FeCl_2 + R_yCl_{x-2};$$

(3) In general, iron sulphide films from active sulphur additives form much more rapidly than ferrous chloride films from active chlorine additives at temperatures above 200° C ; (4) When both active sulphur and active chlorine compounds are present in oil the following effects are generally observed when interaction with iron takes place : (*a*) a rather small proportion of iron sulphide (as $FeS_x$ rather than as HCl soluble FeS)

is found in the reaction product relative to the amount of ferrous chloride present; (*b*) considerably more ferrous chloride (1½ to 3 times as much) is formed than would be formed by the action of the chlorine additive by itself; (*c*) for chlorinated paraffin wax HCl evolution is about the same as it is in the absence of the sulphur additive; (*d*) amounts of $H_2S$ evolved when the additives act together are generally much less on an equivalent basis than the increased amount of ferrous chloride formed; (5) Active chloride additives react more rapidly with iron sulphide or with sulphide-coated iron than with iron itself. Active sulphur additives react much less rapidly with a ferrous chloride coating on iron powder than with iron itself, but this reaction is more rapid than the reaction of chlorine additive with iron; (6) On this basis the following mechanism is proposed for the joint action of active sulphur and active chlorine additives on iron:

$$(a)\ R_2S_x + Fe \longrightarrow FeS + R_2S_{x-1}$$
$$(b)\ FeS + RyCl_z \longrightarrow FeCl_z + RyCl_{z-1} + S$$
$$(c)\ S + Fe \longrightarrow FeS \text{ or}$$
$$(d)\ (n-1)S + FeS \longrightarrow FeS_n.$$

These reactions are comparatively rapid, the ferrous chloride is formed more rapidly by this mechanism than by the reaction of the chlorine additive alone with iron, thus providing a lubricant film under shock loading conditions; (7) Ferrous chloride formed by chloride additives represses the excessive action normally associated with active sulphur compounds on iron; (8) It is proposed that extreme-pressure lubrication is accomplished by a combination of sulphur and chlorine additives in the following steps: (*a*) as the contact points of the gear-teeth heat up, a film consisting principally of ferrous chloride is formed on the points according to the mechanism outlined above; (*b*) as the temperatures become higher, resistance of the ferrous chloride films to shear becomes small, possibly due to fusion (melting point of ferrous chloride = 690° C) or low shear strength of the solid films at high temperatures; (9) Ferrous chloride formed by chlorine additives represses the excessive action normally associated with active sulphur compounds on iron. A. H. N.

**501. Recent Advances in the Chlorinated Paraffins.** R. Strauss. *Refiner*, Jan. 1946, **25** (1), 36–37. (Translated by E. J. Barth from *Oel u. Kohle—Erdoel u. Teer*, 83/85, Feb. 1935.)—Experimental procedure and results obtained from chlorinating paraffin waxes of different types and methods of obtaining substitution products (*e.g.*, amino-waxes) from chlorinated waxes are described. Chlorinated waxes are found to be miscible in all proportions with castor oil and to solubilize it in mineral oil.

A. H. N.

## Analysis and Testing.

**502. A Jet Viscometer with Variable Rate of Shear.** W. J. Morris and R. Schurmann. *Rev. Sci. Instrum.*, Jan. 1946, **17** (1), 17).—A viscometer consisting of a glass jet which is inserted in a closed system is described. This was developed for the measurement of the viscosity of hydraulic oils at high rates of shear of the order of 100,000 $sec^{-1}$.

The jets made by almost sealing off a piece of Pyrex tubing were not true capillaries of constant diameter and definite length, but observations on straight mineral and some fatty oils of viscosity sufficiently high to exclude turbulence showed that Poiseuille's law was obeyed.

Results with colloidal solutions showed that temporary viscosity reductions occurred at high rates of shear—indicated clearly by plotting the reciprocal of time of flow against pressure difference. The onset of turbulent flow was also easily recognizable from such curves.

With this instrument laminar flow was found to persist when Reynolds' numbers up to about 44,000 were encountered. However, the critical Reynolds' number is not necessarily the same for the same oil and two different jets, since the beginning of turbulence may depend upon the geometrical shape of the jet. D. L. S.

**503. Modified Aniline-Point Apparatus for Dark Oils.** N. Madsen. *Refiner*, Dec. 1945, **24** (12), 530.—The apparatus used in an ordinary aniline-point apparatus fitted with a ring stirrer displacing such a volume that the level of the oil-aniline mixture

drops several millimetres when the stirrer is withdrawn from the liquid. The point on the tube wall where the film is observed is thus in contact with the bulk of the liquid except for a brief moment of observation. A shield is provided to decrease the heat transfer between the wall of the aniline-point tube and the surroundings at the point where the film is being observed. This shield also makes it easier to observe the appearance of the film. A. H. N.

## Crude Oils.

**504. Bahrein Island Producers 20,000 Brl and Refines 70,000 Brl/Day.** C. O. Willson. *Oil Gas J.*, 20.10.45, **44** (24), 110.—The refinery and oilfields owned by the Bahrein Petroleum Co., Ltd., are described. The island, on which the discovery well was completed in 1932, is the largest of the group being 30 miles long and 10 miles wide. Oil production is secured from three pays which contribute 20,000 brl/day of crude, the 50,000-brl difference between the field and refinery capacity being supplied by submarine pipeline from the Arabian American Oil Co's fields in Saudi Arabia. A large proportion of the oil is obtained by gas injection.

The principal operating equipment of the refinery consists of two low-pressure atmospheric tower crude-oil distillation units, one low-pressure atmospheric and vacuum tower crude-oil distillation unit, one fluid-type catalytic cracking plant, two thermal reforming, and two thermal cracking units, one thermal gas-recovery plant and one fluid-type isomerisation plant, a sulphuric-acid-type alkylation plant as well as sulphuric-acid manufacturing plants, and the usual treating and sweetening plants for gasoline and kerosine. Previous to the installation of units for the production of 100 octane gasoline in 1944 the refinery was operated for several years as a 34,000-brl refinery in a balanced crude oil distillation, thermal cracking, and reforming operation. The plant output now consists of 100-octane gasoline, 67–80 octane motor fuels, illuminating and power kerosines, as well as diesel and fuel oils.

The Bahrein and Arabian crude oils, which have the following properties, are usually batched in refinery operations :

| | *Bahrein.* | *Arabian.* |
|---|---|---|
| Gravity (° A.P.I.) | 33·2 | 34·7 |
| Sulphur, % wt. | 2·21% | 1·75% |
| Viscosity (S.U./100° F) | 58·5 | 42·7 |
| Pour point (° F) | +20 | +10 |

The Bahrein crude yields approximately 37% of 437° EP gasoline of 40 octane number (C.F.R. M.M.) and a 62% residuum of 20° A.P.I., while the Arabian about the same quantity of 37 octane gasoline with a residuum of about 25° A.P.I. gravity.

On completion of the second steam plant the total capacity will be 430,000 lb/hr at 550 lb. The generating capacity will be 14,000 kw.

Full details as to refinery operations are given, and a brief description of the geological formation of the island is included, together with a map. T. M. B. M.

**505. Evaluation of Lubricating Oil Crudes.** V. A. Kalichevsky. *Nat. Pet. News*, 3.10.45, **37** (40), R765.—A simple method is presented which permits an estimation of the composition of lubricating-oil fractions of crude oil in terms of the four basic components : asphalt, wax, undesirable oil, and desirable oil fractions.

When the crude oil is received by the laboratory, it is first split into various fractions on the basis of individual plant procedures, determining viscosities, and flash points or similar physical properties of the fractions. Distillation procedure should approach as closely as possible the true boiling-point analysis.

Asphalt may be separated from the oil by solvent extraction, using propane or higher alcohols. Wax is separated, preferably prior to deasphalting using solvents such as mixtures of methyl ethyl ketone and toluene, or chlorinated solvents, adjusting conditions on a typical sample to obtain some predetermined pour point. The dewaxed and deasphalted sample is then subjected to a single-stage extraction with a solvent adjusting the quantity of the latter so as to obtain approximately the specification viscosity index on the reference crude-oil sample. The lowest practicable temperatures and largest possible quantities of solvent should be used. Full details of the calculations necessary and the interpretation of laboratory results are given.

T. M. B. M.

## Gas

**506. Utilization of Natural Gas in the United States.** G. G. Oberfell. *Refiner*, Jan. 1946, **25** (1), 6–16.—*Paper presented before American Institute of Mining and Metallurgical Engineers.* An examination of the past and present uses of natural gas clearly indicates its superior qualities for fuel purposes. While considerable quantities are employed in carbon-black plants, nevertheless such use disappears when higher-priced markets and pipe-line outlets become available. The future prospects of the use of natural gas for fuel purposes is very bright. It is expected that as more value is placed upon this commodity and transportation facilities are increased, less natural gas will be used in present low-priced markets. Natural gas as a raw material in the manufacture of chemicals is of considerable economic importance to the chemical industry, but the quantity of natural gas used for producing chemicals is and will probably continue to be relatively small in comparison to the amount used for other purposes.

Natural gas is a more economic raw material than coal for conversion into liquid hydrocarbons by the Fischer–Tropsch process. Modifications of the Fischer–Tropsch process, using natural gas, will undoubtedly find useful applications, particularly where the process can be combined with other processes or with existing facilities. The production of natural gasoline and the manufacture of chemicals afford opportunities for such combinations. However, without the economic advantages of such combinations the available information indicates that as a means of producing gasoline alone the Fischer–Tropsch process would not be competitive with present refinery operations, using crude oil as a raw material, under present prices. Furthermore, the peak of gasoline production from natural gas by the Fischer–Tropsch process will amount to only a minor proportion of the total gasoline supply of the U.S.

A. H. N.

## Engine Fuels.

**507. A Review of the Development of Reference Fuel Scales for Knock Rating.** D. H. Brooks. *Refiner*, Jan. 1946, **25** (1), 42–48.—*Paper presented before Society of Automotive Engineers.* This is a Report of the Co-ordinating Fuel Research Committee of the Co-ordinating Research Council, Inc. The past quarter of a century has witnessed practically all the development of the art of knock rating. The pioneer Ricardo engine and reference scale gave way to a miscellany of engines and scales, from which emerged the CFR engine and the octane-number scale. With the advent of fuels rating above 100 octane number, several systems of extending the octane-number scale were proposed. Of these the principal survivors are the AN performance number, and the AGAC extended octane and index-numbers. Experimental fuels have now exceeded in knock rating the range of these systems. With increasing study of the problem it has become apparent that a single rating scale will not satisfy the needs of all concerned. A scale is needed in terms of which fuel-blending computations can be made readily, and an interchangeable scale is needed by means of which relative engine performance can be expressed. While it is true that such a performance scale can be exact only for the engine on which it was developed, it is likely that with increasing understanding of the problem we shall be able to estimate accurately the performance of the fuel in any given engine, from ratings of the fuel under mild and severe test conditions. The exploratory work of the AFKRS Group of the CFR Aviation Fuels Division leads to the conclusions that the leaded triptane–heptane scale appears to have much promise; that this scale, which is expressible either as triptane number or detonation index, being extensible with accuracy to the upper limit of antiknock quality, is of adequate coverage; and that it is definitely superior in important respects to present reference-fuel scales. Research now in progress may be expected to provide information on which adoption of this scale can be based. Experimental results are presented on all these points, and graphical interpretations are submitted. An interesting graph gives a linear relationship between the reciprocal of indicated mean effective pressure and the per cent leaded triptane–heptane scale, the graph being extrapolated to infinite pressure—*i.e.*, to the absolute maximum possible in engines present and future.

A. H. N.

**508. Knock Ratings of Gasoline Substitutes.** A. D. Puckett. *Bur. Stand. J. Res. Wash.*, Oct. 1945, **35** (4), 273.—Knock ratings of gaseous paraffins and olefines up to $C_4$, and of carbon monoxide, were determined by current motor and aviation test methods. Auxiliary apparatus and modifications of test engines necessary to rate gases are described.

Antiknock qualities of ethyl and normal butyl alcohol and acetone, both alone and in blends, were determined by current motor-fuel rating procedures. Blending characteristics of these materials with straight-run gasolines and naphthas were investigated.

Conclusions were: (*a*) Knock ratings of carbon monoxide and gaseous paraffins indicate that they can be used as fuels in supercharged or normally aspirated engines of higher compression ratio than those available in normal automotive equipment; (*b*) Knock ratings of gaseous olefins will allow their use in present automotive engines; (*c*) Ethyl alcohol/ether blends containing less than 45% vol. ether give relatively knock-free performance; (*d*) Acetone, ethyl, or *n*-butyl alcohol, either separately or in blends, give satisfactory antiknock value; (*e*) The products under (*d*) can be used to extend supplies of gasoline for motor fuels of satisfactory rating; (*f*) Blending 30% vol of ethyl alcohol with 40–60 A.S.T.M. motor octane-number gasoline improves knock rating by approximately 1 octane number for each percent of alcohol; (*g*) Acetone, though giving a higher octane number when tested neat, is less effective in blends than in ethyl alcohol. T. M. B. M.

## Lubricants.

**509. Bearing Corrosion.** H. H. Zuiderma. *Oil Gas J.*, 16.2.46, **44** (41), 100.—Many properties must be considered in the selection of a bearing metal for a given application. The metal should not develop fatigue cracks, and should possess antifriction, non-scoring, and bonding characteristics.

The alloy should have mechanical strength above the fatigue limit, and possess conformability to enable the bearing to adjust itself to slight deflections.

The metal should be capable of embedding small dirt and metal particles. Corrosion is a serious problem with the newer bearing metals containing cadmium or lead.

Bearing metals can be classified into ten groups, mainly according to composition. Tin-base babbitt is the best all-round bearing metal for moderate loads and temperatures, whilst lead-base babbitt is somewhat inferior to the former, but costs less. Lead can be hardened by the addition of a small amount of alkali, usually about 1%, and the alloy has been used in locomotives. It has not the corrosion resistance of babbitt.

Cadmium alloy bearings have excellent mechanical properties, but are subject to corrosion; as are copper–lead alloys, used extensively in diesel engines.

Copper is the principal ingredient of bronzes, and silver finds use with other metals in aircraft engines. Aluminium alloy bearings have many good properties, but possess poor run-in characteristics and are difficult to bond. Zinc alloys are used under mild loads and temperatures, and sintered powered metals find application under similar conditions.

An appendix lists compounds claimed in U.S. patents as bearing corrosion inhibitors. G. A. C.

**510. Bearing Corrosion.** Part 2. H. H. Zuidema. *Oil Gas J.*, 23.2.46, **44** (42), 151.—Data based on a survey of the literature and the results of "Shell" Wood River Research Laboratories investigations on bearing corrosion and its mechanism are presented. Tests on the behaviour of bearing metals under various laboratory conditions indicate that babbitts were attacked to a negligible extent, whilst at the other end of the scale cadmium alloys were attacked to the greatest extent.

Engine tests showed greatest corrosion with cadmium–silver alloy, with copper–lead most resistant. Tests showed that fineness of structure in the alloy is an important factor in corrosion, coarse-structure alloys being least resistant. Corrosion can be prevented by the addition of a small amount of certain metals such as zinc or indium.

Bearing corrosion is of three types: (1) "acid"; (2) "sulphur"; and (3) by aqueous acids. Cadmium and lead are affected by oil solutions of organic acids only

in the presence of oxidizing agents such as molecular oxygen at low temperatures, and peroxides at temperatures above 100° C. Sulphur corrosion of bearing metals containing silver or copper is serious under high-temperature conditions, due to the formation of a complex of bearing metal with a sulphur compound. This forms a beneficial passivating film on the surface, which is decomposed at high temperatures to produce brittle metal sulphides, which are flaked off, resulting in loss of bearing metal. The presence of " fuel acids " of low molecular weight leads to the preferential solution of copper, the mechanism being of the same type as in " acid " corrosion. G. A. C.

**511. Viscosity of Lubricating Oils at Low Temperatures (2).** L. S. Zhedera, Z. Vozzhinskaya, and O. Fedoseeva. *Petroleum*, March 1946, **9** (3), 62.—The fluidity of synthetic oils at low temperatures differentiates them from petroleum oils, but at 100° C the synthetic oils usually have a higher viscosity—for example, Karachukhuri oil ceases to flow at −20° C, whilst the synthetic is still fluid at −30° C, yet is more viscous than the former at 100° C. A table shows the deterioration in an oil when dewaxed at temperatures below −25° to 30° C.

The pour point of an oil should be viewed in conjunction with its viscosity index. The effect of the addition of paraffin wax on the fundamental constants of the oil is tabulated, and it is shown that the higher the viscosity index the greater the mobility of synthetic oils at low temperatures. G. A. C.

**512. Engine Oil Filtration.** M. W. Webber. *Petroleum*, March 1946, **9** (3), 58.—A review is presented of various articles in the literature on full-flow and by-pass filters, mechanical filters, and those of the ultra fine and adsorptive types.

The presence of a contaminated filter cartridge in a lubricating system is a source of trouble, and filters will not solve lubrication problems. Adsorbent-type filter materials tend to disintegrate and introduce abrasive matter to the oil, whilst filters of the absorbent (cotton waste) variety treat only 10% of the oil. Additives are adsorbed from compounded oils and lead salts from leaded fuels.

Claims made for adsorbent type of filter are extravagant.

Felt-type absorbent filters require cleaning every 14 days, and are inoperative after 6 weeks in service. Fine filters, mechanical or adsorbent, are of the by-pass type; and as solid particles are continually entering the oil, this type is not really efficient. Dilution troubles in tractors using kerosine or vaporizing oil as fuel are accentuated by adsorptive filters by removing active molecules which increase viscosity and oiliness. Really efficient filters for air-intake and crankcase breathers are required. Rolls-Royce have developed an efficient filter of the centrifugal type which gives a pressure drop of only 15 lb/sq in when 18,000 pt/hr of oil at −30° C are flowing through it. G. A. C.

**513. Action of Lube Oil Detergents on Automotive Engines.** F. M. Watkins. *Refiner*, Jan. 1946, **25** (1), 1–5.—The term detergency in an oil is explained, and is given a wider meaning than usually is associated with it. Generally speaking, a detergent is a cleansing agent. In lubricating-oil terminology, however, detergency has a wider reference. Detergents present in modern oils are expected to maintain a clean engine as well as to aid in cleaning an engine already containing deposits. Thus an oil which leaves a clean engine may be said to have a high degree of detergency. Synthetic detergents, however, are not solely responsible for engine cleanliness, for deposits are formed in many ways, each of which contributes to the total, and any factor which eliminates one source may aid in effecting an overall improvement. Antioxidants retard deterioration, and in some cases may thereby be said to exhibit a mild detergent action. Oils themselves differ in the rate at which they form and deposit more sludge. Naphthenic oils, for example, dissolve more sludge than paraffinic oils, but oxidise more readily to form oil-insoluble materials. As a result they appear to have greater detergency under mild test conditions, but less detergency under severe test conditions. The common types of detergents are oil-soluble salts of sodium, potassium, calcium, magnesium, barium, aluminium, or cobalt with molecular weight between 500 and 1000. These are discussed under the four classes: soaps, phenoxides, phosphates, and sulphonates. Typical test results on engine parts are described and illustrated. Precautions and procedures to be adopted in using detergents and mixing oils with detergents are outlined. A. H. N.

**514. The Development and Lubrication of the Automotive Hypoid Gear.** F. F. Musgrave. *J. Inst. Petrol.*, Jan. 1945, **32** (265), 32–44.—The history of the use of the hypoid gear and its lubrication since 1925 is given, together with an outlook into the future of such gears. A. H. N.

**515. Investigation of Piston-Ring Sticking in High-Duty Aero-Engines.** A. Lahiri and E. Mikolajewski. *J. Inst. Petrol.*, Feb. 1946, **32** (266), 59–89.—A theory of the mechanism of ring-sticking due to oil deterioration, from the physico-chemical aspect, is presented, with due note of the mechanical factors involved. Ring-sticking is due mainly to the wedging action of carbonaceous "coke-like" substances formed in the grooves by decomposition of products of oil deterioration. There appears to be a critical and optimum set of conditions under which ring-sticking takes place. Under such conditions a maximum amount of asphaltenic substances is formed and coked. A consideration of the asphaltic systems leads to the conclusions that flow behaviour of the deteriorated oil and the nature and proportion of the intermediate products of oil deterioration are the governing factors in ring-sticking, mechanical conditions remaining constant. A report of a discussion follows. A. H. N.

**516. Lubrication Vade Mecum Addendum (3).** E. W. Steinitz. *Petroleum*, March 1946, **9** (3), 67.—In this third part of the Addendum to the Lubrication Vade Mecum notes are given on lubricants for general equipment, including chocolate-making machinery, dryers, sugar-beet graders in the food and allied industries; breaking-up and waste opening machines, flyers and spindles, knitting, wet spinning lace, and jacquard machines in textile and laundry industries; and aluminium, brass and cold-rolling mills and heavy air hammers in the metal industry. G. A. C.

## Asphalt, Bitumen and Tar.

**517. Utilization, Trends, and Future Prospects of Petroleum Asphalt—A Statistical Report.** G. R. Christie. *Oil Gas J.*, 26.1.46, **44** (38), 270.—In the past five years the 10 oil-refining fields of the U.S. have produced 7–8 million tons of petroleum asphalt each year. 70% has been used for paving and 30% for industrial uses, mainly roofing. The proportion used for paving has steadily risen to this figure from 55% in the early 1920's, and has coincided with the development of liquid grades. 500,000 of the 3,000,000 miles of roads in the U.S. are estimated to be of asphalt.

It is considered that there will be an increased tonnage in the form of asphalt roofing for the new houses planned, and the growing aviation industry will call for asphalt runways. Although it is estimated that about 160,000 miles of roads are due to be widened or rebuilt, no exact tonnage can be given for such a programme. It is concluded that there should be a very great and rapid rise in asphalt tonnage in the years ahead, although the rapidity of the rise will depend on the speed of the onset of post-war economy. T. M. B. M.

## Special Hydrocarbons Products.

**518. Gelled Fuel for Flame-Throwers.** C. M. Cawley. *Petroleum*, March 1946, **9** (3), 56.—Mechanized flame-throwers were used in over 500 actions, and achieved successes with very few casualties to the Allies.

This was due to the properties of the gelled petrol used as fuel. This "Fras Fuel" doubled the range of flame-throwers and gave tremendous "target effect." Fras Fuel was developed at the Fuel Research Station at Greenwich. The gelled fuel possesses the property of anomalous viscosity, behaving as a liquid of low viscosity when flowing through pipes and nozzles, but the jet leaving the nozzle behaves as a liquid of high viscosity resulting in long range. The flight characteristics of the fuel can be controlled by modifying the composition to adjust the viscosity. The gelled fuel is very stable, and can be stored for at least one year. Batches of 750 gal were eventually prepared, some 20,000 gal were prepared in experimental batches. Field trials were initially carried out by the Canadian Petroleum Warfare Experimental Unit, and later by the Petroleum Warfare Department. Production was afterwards undertaken by the "Shell" Refining and Marketing Co., Ltd. G. A. C.

**519. Synthesis of Toluene by Hydroforming and Recovery by Azeotropic Distillation.** F. E. Hartley. *Petrol. Engr*, Dec. 1945, **17** (3), 156.—Prior to the war, toluene production in the U.S.A. was 28,000,000 gal/year and was manufactured exclusively from coke-oven operations. To cope with a demand for over 200,000,000 gal/year brought about by the war, the hydroforming process was made available for producing toluene from selected petroleum fractions. Dimethyl*cyclo*pentane, methyl*cyclo*hexane, and ethyl*cyclo*pentane are the chief compounds for synthesis, the two *cyclo*pentanes being first isomerized to methyl*cyclo*hexane and then dehydrogenated to toluene. *n*-Heptane and dimethylhexane may also be present in the feed-stock, but pass through the process unchanged, being removed from the toluene by azeotropic distillation with methyl ethyl ketone–water.

The necessary synthesis compounds occurred to the extent of 1·5% in Los Angeles Basin crude, together with 0·5% of natural toluene, and were concentrated at Union's Los Angeles refinery by heart cutting.

Synthesis conditions in the hydroformer are as follows: (i) Reaction pressure of 150–300 lb/sq in; (ii) Reactor charge temperature 1000–1070° F; (iii) Wet gas recirculation (70% hydrogen) 6000 cu ft/brl of reactor charge; (iv) Catalyst consisting of 10% $MoO_3$ on alumina. The commercial hydroformer runs up to 9000 brl/stream day of charge stock.

Full details of the hydroforming process, the purification and azeotropic distillation of toluene and catalyst regeneration are given, together with numerous flow sheets and diagrams. T. M. B. M.

**520. Hexane Used as Solvent for Soybean Oil Extraction.** R. E. Greenfield. *Oil Gas J.*, 9.2.46, **44** (40), 101.—A new soybean-oil extraction plant in operation at Decatur, Ill., U.S.A., uses a hexane-type solvent and leaves less than 1% oil in the soybean meal, as compared with 4% left by the pressing method. The meal from the extraction process has a 44% protein content, 4% more than when the pressing operation is used.

Extraction takes place in a tower in which operates a large vertical bucket elevator, the buckets being in this case baskets with perforated bottoms. These are loaded with the flaked soybean which is extracted with solvent during their travel.

The solvent has an A.S.T.M. distillation range of 146–156° F and is maintained at 130° F in the extraction tower. The solution of oil in solvent is treated first in atmospheric evaporators, and then in a vacuum stripping tower, where the solvent is removed, separated from water, and returned to the extraction tower for re-use.

Solvent losses are kept below 0·7% of the weight of beans processed. D. L. S.

## Derived Chemical Products.

**521. "O.X.O" Process Made Higher Alcohols from Fischer-Tropsch Olefins.** Anon. *Nat. Petrol. News.* (*Tech. Sect.*), 7.11.45, **37** (45), R926.—T.I.I.C. Report Index No. 3, *Report on Visit to Oil Tragets in the Ruhr and Hanover Areas*, contains a description of an "OXO" (German code name) plant which was part of the operation of the Ruhr Chemie installation at Holten. This plant, which was about complete when the war ended, was intended to treat $C_{11}$–$C_{17}$ olefins, converting them first into aldehydes by passing them, together with sulphur-free water gas, over ordinary Fischer–Tropsch catalyst. The aldehydes were then reduced to alcohols by passage with hydrogen over a nickel catalyst. These alcohols were destined for the manufacture of soap, and possibly edible fats.

The process as developed was to have used a $C_{11}$–$C_{18}$ cut from the Fischer–Tropsch plant, which was dehydrogenated by passage over a mixed thorium/chromium catalyst. The olefins formed were separated into four cuts: $C_{11}$–$C_{12}$, $C_{13}$–$C_{14}$, $C_{15}$–$C_{16}$, and $C_{17}$, which were treated separately. The mixture of olefins and water gas was then passed over the catalyst at 135° C and 150 atm. pressure, using an intermittent process with 20 min cycles.

The aldehydes removed by vacuum distillation were finally reduced using a Ni catalyst at a temperature of 180° C and pressure of 150 atm. D. L. S.

**522. British Made Synthetic Waxes.** Anon. *Chem. Tr. J.*, 8.3.46, **118** (3068), 306.—The Abril Corporation (Great Britain), Ltd., have obtained an extensive block of factories at Bridgend, South Wales, for the manufacture of a new range of synthetic

waxes. A £50,000 plant is being installed for the production of a new series of high-temperature waxes, but various other grades will be produced of interest to many industries.

The new waxes, which have as their basis by-products of the margarine, soap, and other fat-splitting industries, are monomeric substances, and consist as a rule of practically pure chemical entities of long carbon-chain structure with various substituents. They are inert (hydrolysable only under very severe conditions), and to a very large extent resistant to oxidation. The range so far explored have melting points from 65° C to 280° C. Technical details of the process have so far not been divulged.

The corporation visualise a production of 10,000–15,000 tons a year by 1948.

T. M. B. M.

## Coal, Shale and Peat.

**523. Coal Extraction by Solvents (the Pott–Broche Process in Germany).** Anon. *Chem. Tr. J.*, 1.3.46, **118** (3067), 291.—A digest of C.I.O.S. Report XXXI-27 dealing with the coal-extraction plant of the Ruhrol G.m.b.H. at the Hugo Stinnes Werke of the Matthias Stinnes Gewerkschaft at Welheim, Westphalia. This plant was the first and only one of its kind in Germany to operate the Pott–Broche process for the extraction of coal with organic solvents. The extraction process is not thought to be a commercial proposition without the availability of special oils derived from the hydrogenation of pitch for use as solvents.

Coals having more than 25% volatile matter are suitable, and the original solvent was 4 parts of tetrahydronaphthalene and 1 part of cresols (B.R. 190–210° C). This was used with half its weight of coal, but the solvent was later changed to middle oil from coal-tar pitch hydrogenation (B.R. 200–320° C), owing to the suitability of the recovered material for vapour-phase hydrogenation and the fact that the motor fuel produced contained a high percentage of aromatics.

The coal was powdered (for pumping purposes), dried by flue gas to 0·5% water content, and extracted in steam-heated kettles at 60–100° C. The extraction was a batch process. The mixture was then pumped to the preheating and extraction tubes, which were located in a flue-gas furnace maintained at 550° C. The total time from preheater to outlet was about 1 hr, 20% of the time being in the preheater. Filtration of the mixture was effected by porous ceramic candles of special design, which are described in detail. The filtrate was subjected to vacuum distillation, and the extract is said to be completely oil-free. The recovered oil was redistilled, and the small residue returned to the liquid phase hydrogenation plant.

The coal extract was coked for high-grade electrode carbon (0·1–0·15% ash).

T. M. B. M.

**524. Synthesis of (1) Glycerol and Propylene Glycol from Propylene, and (2) Ethylene Glycol from Ethylene.** D. M. Newitt and P. S. Mene. *J. chem. Soc.*, Feb. 1946, 97.—In the early stages of the slow combustion of an olefin at high pressures there is formed a mixture of the corresponding oxide and the isomeric aldehyde and alcohol. Under appropriate conditions of temperature and pressure the oxide is hydrolysed to glycol and the alcohol is further oxidised and hydrolysed to a polyhydric alcohol. For instance, propylene gives propylene glycol and glycerol, and ethylene gives ethylene glycol. The effect of temperature, pressure, and other factors on the course of the combustion is fully described.

T. M. B. M.

**525. Carbon Black.** W. L. Loving. *Petrol. Engr.*, Nov. 1945, **17** (2), 176.—The history and uses of carbon blacks are described. Approximately 90% of the production is used in the rubber industry, 5% in the printing ink and 2% by the paint and varnish, and 5% is divided over the uses for paper, plastics, battery, metallurgical and other industries. Carbon black was first made from natural gas in 1872 and the reciprocal channel process was patented by Melvill in that year. The channel process for carbon black is described. The material from the channel furnaces is "bolted" to remove any foreign matter such as sand or scale or hard carbon particles. This material is fluffy and has an apparent density of 5 lb/cu ft, an agitating process then removes entrained air and the density is increased to about 10 or 15 lb per cu ft at which density the blacks are used for inks or paints. For rubber compounding carbon blacks are

formed by various processes and have a density of from 20 to 25 lb/cu ft and are free-flowing granular dustless products. A thermal process was patented by Brownlee and Uhlinger in 1916, and is described. Briefly the gas is decomposed to carbon and hydrogen in the absence of air, by being brought in contact with highly heated refractory material. An improved method employs part of the hydrogen and produces a somewhat fine particle size black. Both grades have much larger size particles than channel blacks; 6 to 16 lb are produced per 1000 cu ft. Sometimes these thermal blacks are preferred to channel blacks where resistance to abrasion and wear are not important. Thermal blacks are less reinforcing than furnace or channel blacks. The furnace process blacks were first made in 1926; they are produced from natural gas and air in controlled proportions, using about 50% of the air as would be required for complete combustion. This general grade of furnace black is known as SRF (semi-reinforcing furnace) black and, as measured by reinforcing ability and particle size, falls between thermal and channel blacks. The yields range from 6 to 14 lb/1000 cu ft of gas. Approximately 492 million lb of channel black and 77 million lb of other blacks were produced in 1940. Natural rubber was only used then. Channel blacks are used satisfactorily as reinforcing pigments with natural rubber and adds greatly to the wear and abrasion resistance. Natural rubber has a tensile strength of about 3200 p.s.i.; when compounded with carbon black its strength is increased to 4000 p.s.i. Synthetic rubber, Buna-S, has a tensile strength of less than 200 p.s.i., the addition of carbon black raises it to around 3000 p.s.i. and increased quantities are required to compensate for the inherent differences between natural synthetic rubber. With synthetic rubber, furnace blacks provide easier compounding and low heat generating properties than channel blacks. The demand for furnace blacks has grown during the war years owing to the increased use of synthetic rubber and improved qualities have been developed in attempts to attain the good abrasive and high tear resistance properties that channel blacks impart to natural rubber. The natural gas industry is surveyed from the aspect of carbon black manufacture in relation to the location of the producing wells, *i.e.*, whether manufacture is near or remote from the producing centres, and cost of gas, *i.e.*, whether waste gas, which otherwise would be vented to the air, is used. Low cost gas is necessary for the industry. Sour gas can be used without sweetening, though it is better sweetened, cost of corrosion of plant must be considered against cost of sweetening. By using sour gas carbon black manufacturers have used a raw material that might have gone to waste. From 1000 cu ft of natural gas only 1·5 lb channel black and only about 10 lb of furnace black can be recovered. The economics of the industry are discussed. The future for carbon blacks is reviewed, production of types will depend upon the relative supplies of natural rubber available. Quality of furnace blacks will tend to approach channel black quality, but the yields of furnace blacks will then be lower than by the present furnace production. W. H. C.

## Miscellaneous Products.

**526. Corrosion-Resisting Plastic Material Applied to Oil-Field Equipment in Place.** E. H. Short, Jr. *Oil Gas J.*, 22.12.45, **44** (33), 59.—A description of the use of air-drying thermoplastic synthetic resins as a means of preventing corrosion. It is possible to bake a material of this kind on pipe and other equipment at a central plant, thereby enabling the coating to withstand considerable heat, or a type of synthetic resin which is unaffected at 180° F may be applied directly in the field. Application of the latter type involves first the sandblasting of the surfaces to be coated or, in some cases, cleaning by wire brush or industrial cleaning compounds. The resin coating, usually vinyl acetate, is applied by means of a spray gun. Generally one prime coat and two finish coats are required on external surfaces, and a 30-minute drying period is necessary for each except the last one. A period of 48 hours should be allowed to elapse before the plastic surfaces are exposed to corrosive liquids. Data are given regarding the time taken for treatment, and also the physical properties of the film, the thickness of which is of the order of 0·003 inch per spray coat. The resistance of typical films to various reagents are tabulated, but it is pointed out that a period of several years (depending upon the type and severity of the corrosion) will be required completely to evaluate the protective value of plastics as applied to oil-field equipment.

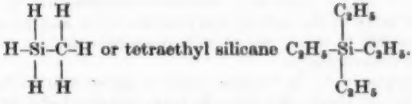
T. M. B. M.

**527. The Amazing New Chemical Family.** A. L. Foster. *Oil Gas J.*, 6.10.45, **44** (22), 86.—A survey of the history, application, chemistry, and properties of the silicones. These were first synthesized some 40 years ago, and considered to be chemical curiosities, but have since been put to a number of important commercial uses. One of their main applications to the petroleum industry is in lubricating greases, owing to their very high viscosity index, and operate satisfactorily at temperatures between 40° and 400° F. The greases are highly resistant to acids, alkalies, and oxidants, and are unaffected by steam and water. A coating of silicone grease is useful in preventing corrosion of metal surfaces, and can also be used for preventing contained materials from adhering to the surface of drums coated in this way.

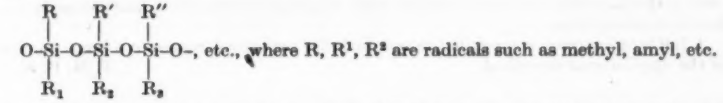
Silicone "rubber" is used for aircraft engine supercharger gaskets and similar applications, but owing to its low tensile strength cannot be applied for tyres. Remarkable results are also claimed for silicone resin varnishes for insulation of electrical goods, and for water-proofing.

Vapour-pressure curves are given for several typical silicones of Dow Corning production, and data are included on the viscosity of silicone liquids and oils to which these have been added.

The type component of a silicone is silicane, $SiH_4$ (analogous to methane), and from which substituted silicanes are derived such as methyl silicane :




Silicones are probably formed by joining two or more silicanes containing one or two unattached valencies by means of oxygen atoms, when the general configuration becomes :—




The oldest and most common method of preparation is via the Grignard reaction when the latter reagent reacts with silicon tetrachloride to form dimethyl-silicon dichloride $(CH_3)_2SiCl_2$. This is hydrolysed to form the diol $(CH_3)_2Si(OH)_2$, which decomposes rapidly, liberating 1 mol of water to form the silicone monomer $(CH_3)_2SiO$, which polymerizes rapidly. Other methods of preparation are also discussed in detail.

Some of the silicon polymers are liquids, with pour points as low as −85° C and show no obvious signs of oxidation at 150° C. The elastomer type may be used to make a silicone rubber which hardens only at temperatures below −55° C. The "bouncing putty" is one of the methyl silicone polymers which strongly resists quickly applied distortional forces, yet may be moulded like putty when the force is applied slowly. The degree of linkage in the polymer molecule is thought to have a great bearing on the properties of the product.

A list of references to the literature is appended. T. M. B. M.

**528. Ultrasonic Naftalan Emulsions.** M. M. Nevyadomskii. *Nauka i Zhizn*, 1945, No. 4, 22–23.—By means of ultrasonic vibrations it has been found possible to prepare stable oil-in-water emulsions containing up to 12% of gas oil, the latter being obtained from crude from the Naftalan field. The emulsions have been found to possess curative properties with respect to cancerous tumours, both in animal and human subjects. Following successful animal (mouse) experiments, a series of 498 cases of severe internal human cancer were treated by injection of a 12% emulsion. A favourable response was obtained in 93% of the patients and in 27% of these the improvement was maintained for a period exceeding 9 months, and lasting in some cases up to 4 years. V. B.

**529. Colloid Chemistry of Clays.** E. A. Hauser. *Chem. Rev.*, Oct. 1945, **37** (2), 287.—The industrial applications of clays are discussed in the light of their colloidal nature. The significance of the colloidal state of matter is explained, emphasizing the import-

ance of the large surface/total volume ratio and the formation of diffuse electric double layers by colloidal micelles.

In order to explain the properties of clays, a clear picture of the shape and actual dimensions of colloidal clay particles is necessary, as well as the chemical composition. This has been obtained by X-ray diffraction and electron-microscope studies. An explanation is also given of the fact that a clay particle when dispersed in water must be regarded as a colloidal micelle. This concept is used to explain many of the phenomena typical of clay minerals, such as ion exchange reactions, plasticity, thixotropy, dilatancy, rheopexy, dispersion, and stream double refraction.

These phenomena form the basis of the industrial application of the clays, and those fields of science and technology in which the importance of the colloidal chemistry of clay minerals has been proved are discussed. They include the use in ceramics, agriculture, soil engineering, oil-well drilling, films and plastics, thixotropic pastes, and water-softening. The use of clays in the production of emulsions, in the bonding of foundry sands, in insecticide and fungicide or bactericide sprays, and in lubricants is mentioned, as well as the many new applications which are likely to arise. V. Bu.

**530. The Versatile Alkyds find New Uses.** G. Leffingwell and M. A. Lesser. *Chem. Ind.*, 1946, **58** (1), 60.—The many and varied application of alkyd resins are described. The normal type of alkyd resin is a chemical combination of glycerine, phthalic anhydrides and oil fatty acids, but by varying the type and proportion of the basic ingredients it is possible to create resins with properties desirable in or essential to the specific application contemplated.

A list of their applications in various fields is given and includes: coatings and finishes of various kinds, sheets and films, flexible abrasive belts, safety glass, linoleum, brake lining, and electric insulating materials. Their use as insecticides is also described; a 2% glyceryl phthalate alkyd resin in water was applied to plants heavily infested with red spiders, and these pests quickly disappeared. They have also been used in the manufacture of special lubricants and, suitably modified, find use as emulsifiers and demulsifiers.

A full bibliography is appended, which includes patent references to a large number of the applications described. T. M. B. M.

**531. Styrene Copolymers in Surface Coatings.** D. H. Hewitt and F. Armitage. *Paint Mnfr.*, March 1946, **16** (3), 91.—An account is given of the use of copolymers of styrene with drying oils in the production of surface coatings, and copolymerization techniques are discussed. Copolymerization with butadiene gave polymers in which cross-linking could be effected by vulcanization. Styrene polymerized with dehydrated castor oil over a wide range of proportions and viscosities to form homogeneous products. The standard formulation was 50 parts drying oil, 50 parts styrene monomer and 100 parts solvent, which yielded a varnish with a clear, quick-drying film hardening by oxidation after addition of usual driers. Useful products could be obtained within the range of from 40 parts of styrene to 60 parts of oil, to 60 parts of styrene to 40 parts of oil, with 100 parts of solvent. Clear films were yielded; at 40% oil length rather brittle, and at 60% oil length flexible, dufable, but slow drying.

If polymerization was carried out in the absence of solvent with 50 parts styrene and 50 parts D.C.O. a heterogeneous mass resulted; the solventless type of product was permanently thermoplastic, thus differing from the solvent type. Replacement of the xylene solvent by white spirit gave opalescent solutions, with a rather quicker rate of viscosity increase. The styrene copolymers have good paint-making properties, including rapid air-drying, with subsequent after-hardening, good stability towards pigments, are water resistant, and have good electrical properties.

The mechanism of copolymerization was as yet little understood. It was thought that styrene polymerization with non-conjugated unsaturated fatty acid radicles was a chain transfer process, and with conjugated radicles propagation of the styrene chain across the conjugated system was involved.

In the discussion, the authors stated that a number of inconclusive experiments had been made with oil of the Bis-Oil type. Work had been done on the precipitation of copolymers, and the material was found to have satisfactory adhesion characteristics. G. A. C.

## MISCELLANEOUS.

**532. Wilson, Coleman say Industry can meet predicted increase in Oil Demands; urge freedom of Technological Research.** Anon. *Nat. Petrol. News*, 10.10.45, **37** (41), 19.—The full texts are given of the reports on world petroleum resources presented by S. P. Coleman and Dr. R. E. Wilson, on behalf of their investigating committees, to the United States Senate Committee on petroleum resources. Mr. Coleman's report covers the world distribution and the United States, supplies and potential production of crude oil, and the products therefrom are shown, as forecast estimates for the years 1947 and every five years up to 1965, in comparison with statistics for prewar years. It is considered there is a more than adequate supply to meet the world's needs, since actual and potential production in foreign areas greatly exceed the future consumption estimates. The forecast of trends of petroleum requirements for the periods 1921–1944, 1947–1965 are given. The estimated consumption of petroleum products in the United States are given, and discussed under individual products: motor fuel, aviation gasoline; gasoline for other purposes; kerosine; distillate fuels; residual fuel oils and lubricants. Data are also given for the same periods as to the increase in fuel burnt in and the increase in number of domestic burners, the increase in numbers of passenger cars and the decrease in fuels consumption per year per burner, and the decrease in motor fuel, per car, per year, due to improvements that will eventuate in the future. Dr. Wilson in his report, which covers rather the technological aspects of the industry, states that America's capital consumption of petroleum is 30 times the average of the rest of the world. He declared that the American petroleum industry has never failed to meet the demands, despite the upward trend in consumption estimated, and will continue to do so, provided the National policy is broad and non-restrictive. He gives warning that heavy importation from foreign sources, where low discovery costs and high production per well characteristics prevail, which at little or no duty could result in a price depression, and so cause disastrous results on America's producing and refining industries. W. H. C.

# BOOKS RECEIVED.

**Teoriya Avtomobilya. (The Theory of the Motor Car.) Pt. I. The Stability of the Motor Car with Respect to Skidding.** By E. A. Chudakov. Moscow-Leningrad, 1944. 291 Pp.

This work is published by the Academy of Sciences of the U.S.S.R. The present portion, Part I, is exclusively concerned with a study of the movement of a car in the horizontal plane. The subject of movement in an inclined plane, and also when skidding has already started, will form the subject of subsequent parts. As may be expected in a subject of this nature, the treatment is largely mathematical, the forces acting on a car and on its various components under different conditions being analyzed. The effect of the various types of differential construction is discussed, and the work concludes with an examination of the skidding tendency when the vehicle is proceeding in reverse. V. B.

**Proceedings of the Institution of Automobile Engineers.** Vol. XXXVIII, 1943–44. London: The Institution of Autmobile Engineers, 1946. Pp. 403 + xxxix.

Included in the papers read before the Institution of Automobile Engineers during the Session 1943–44 are "Heavy-Duty Motor Oils," by K. Arter, and "Petrol: Its Development, Past, Present, and Future, with Some Notes on the Potentialities of High-Octane Fuels for Road Vehicles," by H. Fossett. Reports of the discussions of these papers are given.

**Transactions of the Institute of Marine Engineers.** Vol. LVI, 1944–45. London: The Institute of Marine Engineers, 1946. Pp. 264 + xl.

Among the papers in this volume are "The Design and Construction of Diesel-engined Tankers," by H. S. Humphreys, and "Heavy-Oil Engine Progress," by J. W. Armstrong. Papers on diesel machinery for cargo vessels of low power are also included.

**1945 Supplement to A.S.T.M. Standards including Tentatives. Part I. Metals.** Philadelphia, Pa.: American Society for Testing Materials, 1946. Pp. 395 + xiii.

This supplement contains the newly adopted and revised standards and tentatives in the metals field accepted since the appearance of the 1944 book of standards.

**Quarterly Journal of the Geological Society of London, Vol. CI, Parts 3 and 4.** London: Longmans, Green & Co., 1946.

Contains the paper on "The Geological Results of the Search for Oilfields in Great Britain," by G. M. Lees and A. H. Taitt, read before the Geological Society on December 6, 1944.

# ABSTRACTS.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# Oilfield Exploration and Exploitation.

## Geology.

**533. Petroleum Reserves of the World.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 172.—The world's petroleum reserves are shown graphically by countries for 1st January, 1944. The total is 50,000 million brl, U.S.A. having 20,000 million, South America 6700 million, Europe 600 million, Russia 5900 million, the Middle East 15,700 million and the Far East 1070 million brl.

U.S. domestic reserves represent 39% of the total, and U.S. foreign reserves are 19%; British Empire reserves are 2% of the total, and British foreign reserves amount to 20%. The U.S.S.R. has 11% of the reserves, while the Netherlands control 5%.

G. D. H.

**534. Classification of the Petroleum Possibilities of the World.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 174.—A small map of the world shows the areas which are most favourable as regards oil possibilities, those which are unfavourable, and those which may possibly have oil reserves. G. D. H.

**535. Venezuela's 1946 Exploratory Programme Biggest in History.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 265.—The Venezuelan Oil Law demands that at least half of the concessionary acreage must be relinquished to the Government at the end of a three-year period from the date on which the concessions were granted. This is largely responsible for the intensive exploratory programmes undertaken in order to select acreage.

In 1945 27 seismograph parties, 9 gravity-meter parties and 14 geological parties operated.

Creole plans to drill 30 slim holes to an average depth of 5000 ft to evaluate geological and geophysical work on its Guarico concessions. Six geological tests have been drilled north of Jusepin, and tests have been drilled north and west of the discovery well, 1 Capacho, in northeast Anzoategui. A further test is 5 km south of Quiriquire.

Shell's 1945 exploration programme was greater than that of any other company in Venezuela. Structural drilling has been done in the Greater Oficina area. Geophysical work will be increased in 1946.

In the Guico area Socony has drilled 23 geological tests to an average depth of 2700 ft.

Tables give the types of exploration parties operated by the different companies in eastern and western Venezuela in 1945, while notes add some details. G. D. H.

**536. Exploration in Eastern Ecuador.** J. E. Thomas. *Oil Wkly*, 7.1.46, **120** (6), 41 (*International Section*).—Shell's 25-million-acre concession in Eastern Ecuador stretches from a point 50 ml from Quito to 200 ml farther east. Field work began in 1939. The best geological exposures are in the foothill belt. Geological reconnaissance from the air, and detailed ground work supplemented by seismic work soon disclosed some structures. The first test location was made on the Vuano anticline. Vuano 1 is about 5 ml northeast of Arajuno. It has been abandoned after a series of unsuccessful completion attempts in both the Upper and Lower Cretaceous. The total depth is 5187 ft. Perforations were made at 5000–5035 ft, and at the base of the Hollin sand at 5175 ft. Both sets of perforations tested fresh water with some oil. Tests in the Napo limestone, after plugging back, also failed.

The Napo limestone and adjacent formations have seeps in this area.

No. 2 Vuano will be 6 ml north of No.1, while No. 3 will be 12 ml southwest of the Arajuno landing strip.

The transport difficulties are described. G. D. H.

**537. Chile's "Farthest South" Exploration.** J. E. Thomas. *Oil Wkly*, 7.1.46, **120** (6), 24 (*International Section*).—Two test wells are now being drilled by the Government of Chile near Punta Arenas.

Most of the exploratory work was geological on the Brunswick Peninsula; it was purely geophysical on the Isla Grande of Tierra del Fuego, which is covered by glacial drift. Numerous gas and some oil seeps have long been known in this area. Wells drilled on the Brunswick Peninsula and near Punta Arenas some 15 years ago gave

negative results, although several reported gas-shows and one had oil-showings at several horizons, from one of which 30 brl of oil was recovered

Ten closed structures have been worked out since 1941. The Spring Hill well has passed 6800 ft, and may be carried to 11,000 ft. Production is hoped for in the Tertiary or Cretaceous. This is a purely seismic location. A little to the south a location has been made on the Little Spring Hill structure. 50 ml southeast is the location on the Seven Lakes structure.

On the Brunswick Peninsula the well on the Mina Rica structure has passed 1900 ft. This structure, together with Canelo, Rio Grande, Englefield, and Punta Prata, are geological finds. Supplementary geophysical work has been done on Rio Ganso, Rio Patos, and the Laguna Blanca structures.

Brief notes are given on the organization responsible for developing oil in Chile.

## Geophysics and Geochemical Prospecting.

**538. Electronic Principles Used in the Discovery of Oil.** A. Gibbon. *Oil Wkly*, 14.1.46, **120** (7), 33.—F. S. Craver has devised an instrument which is stated to detect subsurface oil by recording electronic emanations on a series of sensitive screens. The locations of 145 oil-pools are said thereby to have been predicted before drilling the discovery wells.

The device is claimed to show the area of saturation, the approximate depth of one or more producing horizons, the relative recovery of oil per acre, and whether the oil is of high or low gravity.

Of 1569 wildcat prospects surveyed and later drilled, 1333 were correctly predicted as showing non-commercial saturation, and there were 5 errors, while 148 were correctly predicted to have commercial saturation, and there were 83 errors.

It is assumed that all substances give off emanations, and a screen has been constructed to record these emanations. The main emanations appear to diffuse almost vertically, while the secondary diffusion is in all directions. Depths are determinable only at the edge of the deposit.

The emanation intensities associated with commercial accumulations vary in different areas. Natural gas gives no recording, but a highly gas-saturated oil gives a higher recording than one with less gas. G. D. H.

## Drilling.

**539. Some Problems Encountered during Well Shooting Operations in the Nottinghamshire Oilfields.** J. F. Waters. *J. Inst. Petrol*, March 1946, **32** (267), 119–132.—The principal producing sandstones of the fields were millstone grit of very variable nature as far as porosity and permeability are concerned, and were shot to increase permeability. The paper describes the charges used and, in full detail, the timing mechanism adopted. The final form of the timing mechanism used incorporated a small cylindrical piece of lead under tension which flowed plastically to failure and caused a switch to close, thus exploding the charge. A. H. N.

**540. Review of Oil-Well Cementing Practices in California.** O. O. Dale. *Petrol. World*, Feb. 1946, **43** (2), 41.—A general discussion of cementing by the older methods of mixing and the more modern bulk methods is given, together with a description of the two-plug method of cementing and of squeeze cementing. Mud compression under the high pressures used up to 3% is commonly met, and in rare occasions compressions of 20% are recorded. This compression is due to occluded gas in the mud or oil fluid which is used. Methods of measuring compression are outlined. The preparation of ordinary and of gel cement is reviewed. Cementing equipment and use of plastics are very briefly mentioned. A. H. N.

## Production.

**541. Well Spacing and Oil Recovery.** W. C. Kite. *Oil Wkly*, 11.3.46, **121** (2), 50.—Several graphs are presented showing the economical advantages of using close well spacings for oil recovery. Production figures show that increased well density results

in increased recovery. Within practical limits there is a definite mathematical relationship between spacing and recovery. An analysis of the various items of cost of producing oil in the Mid-Continent indicates that spacing of around 10 acres probably gets maximum profit/dollar expended. Studies of the relationship between spacing and actual recovery show that we may expect twice as much oil from a field if a pattern of 4 wells to a 40-acre tract is used instead of one well to 40 acres. If 4 wells are drilled on 80 acres the recovery should be about 2½ times as much as only 1 well. Again, 4 wells on a 160-acre tract will produce 3 (to 3 plus) times as much as only 1 well on the 160 acres. It is claimed that wide spacing will do little to increase profits for deep drilling. A. H. N.

**542. Graph for Estimating Recoverable Oil by Volumetric Method.** L. L. Foley. *Oil Wkly*, 25.2.46, **120** (13), 40.—A graph is presented for estimating the reservoir capacity from porosity data. A. H. N.

**543. Proper Flood Injection Pressures.** Anon. *Oil Wkly*, 25.2.46, **120** (13), 38.—The phenomenon of a sudden critical pressure in flooding operations beyond which appears a rapid rise in the rate of flow is described and illustrated graphically. Two theories are put forward to explain what takes place. One school of thought holds that the overburden between the oil-sand and the surface is actually lifted or sheared above the sand, while the other thinks that a radial fracturing or shearing of the sand itself results. The former group is backed by the quite obvious fact that the over-burden on any oil-sand weighs only so much/square inch on the sand top, dependent on the overburden density, and that when this weight/square inch is exceeded by water pressure in the sand plus a certain factor for the shearing action the overburden may be lifted. The latter group is based in the belief that a shearing of the sand takes place when the critical pressure is reached by the observation in field operations that wells in the same field with about the same amount and nature of overburden have widely variant critical pressures. Both groups are aware of the fact that many input wells have different critical pressures at various times during their life, and that no data are available for definitely predicting critical pressures in a certain well. The definition of critical pressure is lacking, but it usually approximates 1 lb/ft of well depth on the surface. For example a 900-ft well should have a critical pressure approximating 900 lbs on the surface. This figure is accurate enough to use in designing surface equipment and estimating corresponding input and recovery rates. A. H. N.

**544. Complete By-passing of Oil in Water-Flooding Operations.** M. Stekoll. *Oil Wkly*, 11.3.46, **121** (2), 39.—Complete by-passing of breakthrough in water-flooding operations refers to a condition where the injected water does not force any oil to the producers and where the oil consequently is by-passed by this water. Data are presented on by-passing conditions in two fields of S.E. Kansas. In these two fields injection rate rather than pressure appears to determine by-passing action. Each injection well in these two fields is found to have a certain rate above which by-passing will consistently occur. In addition, the maximum rate of injection/foot of permeable sand for each field is fairly uniform. The by-passing or breakthrough rate in a sand determines economic well spacing, and is a major factor for consideration in water-flood development. The data as given in this paper are obtained from two fields in S.E. Kansas, one field producing from the Bartlesville sand and the other from the Wayside sand. The conditions as found in these two fields are not necessarily applicable to other areas. It is suggested that the pressure–intake curves as obtained from other areas be reviewed with the possibility of discovering whether or not rate is a significant factor in determining by-passing action. It is also suggested that the by-passing curves are most important for an efficient flooding operation, and that these curves should be obtained for injection wells to determine the maximum rate at which the field may be flooded and to prevent operation at an inefficiently high or low injection rate. A. H. N.

**545. Casinghead Gas Conservation.** C. C. Pryor. *Oil Wkly*, 11.3.46, **121** (2), 56.—Humble Oil and Refining Co's intended policy for conserving casinghead vented gas are described. This policy includes the principles of: (1) completing and operating oil wells and oil reservoirs in such a manner as to result in a minimum production of casinghead gas and maximum efficient oil recovery; and (2) marketing, consuming, or

returning to the producing reservoir the produced casinghead gas wherever such disposition is economically feasible. Humble has made definite plans for conserving the vented casinghead gas in 11 fields amounting to 60,822,000 cu.ft/day. This figure represents 76·1% of the total 79,526,000 cu.ft/day of gas vented on Humble leases in District 3. The methods adopted in the different fields of the company are briefly described. A. H. N.

## Oilfield Development.

**546. World Crude-oil Production.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 176.—A table gives the daily average production of the principal countries, starting in 1943 (Russia and the Axis-controlled areas are excluded).

Data are also given on the estimated postwar refinery crude runs in comparison with war-time runs, and estimated post-war production in comparison with war-time production (again the Russian areas are excluded). G. D. H.

**547. Oilfields of England.** J. B. Eby. *Oil Wkly*, 7.1.46, **120** (6), 3 (*International Section*).—Eakring and Duke's Wood are the most important of England's 5 oilfields. Both are on the same general structure. Kelham Hills is several miles to the southeast. These three provide the bulk of the annual output of 490,000 brl.

England's first oil-well was at Hardstoft. From 1937 to 1939 seismic reflection work was carried out in the east Midlands area. Refraction work followed, and proved more satisfactory. The surface rocks are Triassic. Oil occurs in the Carboniferous in small, low-relief anticlines, on the gently dipping flank of the Pennine anticline.

Eakring has 54 wells, Duke's Wood 112, Kelham Hills 54, and Caunton 10. All the structures are faulted domes. Well depths range 1800–2680 ft. The oil-sands are sometimes lenticular. At Eakring the main production is from the Rough Rock. Porosities range 0–20%, and permeabilities 2–1000 md. Well spacing is one well to 2½–3 acres. Initial outputs have ranged 7–375 brl/day. Gas/oil ratios are low, being 10–20 volumes of gas per volume of oil. The oils are considerably under-saturated, and production declines rapidly until the saturation pressure is reached. The later decline is slow. The original reservoir pressure at Eakring was 990 lb/sq. in. in at 1700 ft sub-sea level; the saturation pressure was 390 lb/sq. in. The initial pressure at Kelham Hills was 1200 lb/sq. in at 2000 ft sub-sea level, and the saturation pressure 90 lb/sq. in. Each sand is under water drive.

The crude is very waxy, and wax and oil-water production cause trouble. Shooting has proved beneficial. The drilling and completion techniques are described. Tables give details about the producing horizons, wells, production, oil-water levels, the oil composition, and a list of wildcats.

The Formby shallow drilling in a seepage area has given some production. 45,000 brl has been obtained from 12 pumping wells. The oil comes from the Trias, but seemingly has a deeper source. A deep well has reached 6380 ft without finding the source.

The Hardstoft well has been cleaned and treated with acid. During the war it gave 8700 brl of oil, and it is still pumping a little oil with much water. G. D. H.

**548. Nation's 25,840 Completions Fall Short of 1945 P.A.W. Goal.** Anon. *Oil Wkly*, 21.1.46, **120** (8), 50.—In 1944 24,455 new wells were drilled in U.S.A.; the 1945 figure was 25,840. In 1945 Texas had 7410 new wells, 18·8% more than in 1944. Pennsylvania had 2929 new wells in 1945; the 1944 figure was 3060.

The 1945 completions included 13,737 oil wells, 2587 gas-wells, 7129 dry wells, 492 deepened wells, and 1895 input and disposal wells.

A table summarizes the December 1945 completions by States and districts, and gives similar figures for the whole of 1945. G. D. H.

**549. Western Oklahoma's Prospects Bright.** A. Gibbon. *Oil Wkly*, 21.1.45, **120** (8), 40.—With one or two exceptions active drilling in wildcat areas has been confined mostly to the eastern fringes of western Oklahoma. The possibilities of developing new oilfields along the western rim of the Nemaha Ridge are by no means exhausted. In the first 10 months of 1945 about 40 new oil- and gas-fields, new pays, and extensions

were found west of the Indian Meridian. The Wichita Mountains and the Nemaha Ridge have influenced nearly half of the new discoveries.

Exploration and development in Western Oklahoma will be influenced largely by the results of geological and geophysical studies in the Anadarko Basin.

In northwest Oklahoma and adjacent areas there is a regional monocline dipping south. The oil of the Texas Panhandle fields may have migrated from the Anadarko Basin. The geological picture in West Oklahoma is not clear, and at times the seismic work is uncertain. With few exceptions all the producing sands found in eastern Oklahoma are expected to occur in the West, and they will be thicker and more prolific, though deeper. The Pennsylvania sands are especially attractive, and the Ordovician sands may be well developed and deep.

Oil has been found in Cimarron County, in the Panhandle. Production is from the Cimarron sand at 4786–4790 ft. About a mile south and west the Cherokee sand has been found to be saturated at 4846–4861 ft.

Drilling in Beaver County may be influenced by the recent gas discovery in southwest Meade County, Kansas.

It is expected that when the geological pattern of Western Oklahoma is worked out lenticularity and stratigraphic traps will be found to hold much, if not most, of the oil found in the region. On the western edge of the Nemaha Ridge conditions are favourable for Hunton lime and stratigraphic traps.

The Marlow–Duncan area of northwest Stephens County has distillate production. The Lamont pool of Grant County yields oil and water from the Wilcox. Wells in Woods County have given fairly good shows in the Pennsylvanian. Ringwood provided Major County with its first commercial production. This area is in the heart of the Anadarko Basin, where producing sands are expected to be thick, and where the Pennsylvanian, Mississippian, and possibly the Ordovician will be tested.

A new gas-pay at 6786–6810 ft has been opened in the old Erick gas-pool of Beckham County. The original production was in the Permian at 2400 ft. The new pay is an arkosic limestone of the Lower Pennsylvanian. The Chitwood pool of Grady County was opened by a well giving 95 million cub. ft of gas and 250 brl of distillate/day from the Lower Pennsylvanian at 10,879–10,889 ft.

A map shows the discoveries made in the first 10 months of 1945. G. D. H.

**550. Triple-zone Completions in Eastern Venezuela.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 227.—The Greater Oficina area has been under development for about eight years. It has several comparatively large fields, as well as smaller ones, none of which has been completely developed. Most wells have 2 to 6 distinct and separate productive sands. There have been as many as 30 distinct productive sands in one field. Most of the sands are thin, and often they are not extensive. At West Guara, however, the sands are thicker and more extensive. West Guara has 29 triple-zone completions, and East Guara 5. This technique saves steel. A single or a dual completion costs about $65,000, while a triple completion costs $70,000, and gives a further 400 brl/day.

The technique of making a triple-zone completion is described. It seems likely that the obligatory use of small annuli will keep the well on flowing production longer than with a large annulus. G. D. H.

**551. Demand for Venezuelan Oil in 1945 is Supplied Despite some Complications.** M. C. Cody. *Oil Gas J.*, 29.12.45, **44** (34), 215.—In 1944 Venezuela produced 256,953,960 brl of oil. The output in the first ten months of 1945 was 262,613,064 brl. In the early part of November the output exceeded a million barrels per day, compared with a daily average of 770,617 brl in the first quarter of 1945.

Venezuela can now supply medium and light, as well as heavy, crudes.

In the first ten months of 1945 Creole drilled 193 development wells, 90 being at Jusepin. Capacho 1 opened the Capacho field, but has been followed by 3 dry wells. Shell has drilled 6 Cretaceous producers at La Paz, raising the production from 14,000 to 28,000 brl/day. In the Cabimas field Venezuela's deepest well is suspended at 13,034 ft. The Mara field has one producer.

The Guara field has been extended westwards, but the Santa Barbara field has proved disappointing in giving smaller wells than expected. The wildcat 8 Laguin,

in the Pueblo Viejo area, south of the Lagunillas field, was completed in May at 3050 ft, for 2390 brl/day.

Socony-Vacuum has drilled 13 producers at Guico during 1945. Consolidada drilled 52 producers in the Santa Barbara and Muri fields during the first ten months of 1945.

Texas completed Delta Amacuro 1 in the vicinity of Tucupita in May. Data on the findings of Nos. 3, 4, and 5 have not been revealed. S.A.P. Las Mercedes commenced drilling Grico 1 and Camaz 2, and has drilled 12 development wells in the Las Mercedes field. Venezuelan Atlantic is drilling 3 wildcats in the vicinity of Santa Barbara, Muri, and Mulata. Three other wildcats and 2 Morichito and 1 Punta Gorda in the same general area have been abandoned as dry holes. Avipa 1 in the Pirital area was completed as a small producer at 4818 ft.

Notes are given on the development and wildcat drilling activities of the various companies. Tables give their outputs by months during 1945, and monthly outputs are given for the more important fields. Maps show the locations of the wildcats drilled during 1945. G. D. H.

**552. Deep Potentialities to be Tested at Amana, Venezuela.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 293.—In 1939 production started from the TR and TRN fields (Temblador); in 1940 shipments began from the El Roble field, and in 1943 from the Amana (Mulata) field. In the first ten months of 1945 these properties averaged 35,216 brl/day, compared with 22,106 brl/day in 1944.

Two wells have been completed on the Pirital block by Atlantic under the Atlantic–Pantepec agreement. Avipa No. 1 was a 150 brl well, and Morichito No. 1 was abandoned because of mechanical difficulties. Punta Gorda No. 1 was abandoned below 6000 ft. Obligatory wells, 1 San Pedro and 1 Hueso, are to be taken to a minimum depth of 8000 ft, and Tonoro No. 1 is being drilled because of favourable indications and to make up footage requirements.

43 wells were completed in the first ten months of 1945 at Amana (Mulata), giving a total of 128 oil-wells, 6 gas-wells, and 8 dry holes. The aim is to maintain a potential of 30,000 brl/day. The cumulative output is 14,676,005 brl. Wells in the Mulata field range 4500–6500 ft in depth. The deeper productive possibilities of Amana are to be explored.

At El Roble the well depth averages 9000–10,000 ft. At the end of August the cumulative production was 9,836,877 brl. Special problems have been encountered in drilling, completing, and operating the wells.

Seven wells at Temblador were reopened for production in March 1945.

El Roble, according to the Dodge–Bennett report, had a developed reserve of 27,970,000 brl, with a further 103,500,000 brl of proven but undeveloped reserves, and prospective reserves of 393,530,000 brl, on the basis of engineering and geological data. Mulata's reserves are said to exceed the proven reserves at El Roble. The reserves of Tabasco, TR, and TRN are not considered to be extensive. G. D. H.

**553. International will Increase Drilling in Peru, Chile, and Ecuador.** Anon. *Oil Gas J.*, 29.12.45, **44** (34), 236.—The proven oil area of the La Brea–Parinas Estate covers 20,000 acres. 3500 wells have been drilled and 1200 abandoned. Many of the wells are over twenty years old, and now give less than 10 brl/day. At present 52% of the output is from flowing wells. There are 5 producing horizons, the Parinas now giving almost all of the flowing production, and being subject to complete pressure maintenance. An experimental water-flood has been initiated in one of the Verdun formation pools. The pools are naturally solution-gas drive pools. The Estate's output is declining in spite of increased drilling activity.

The output of the De Mares concession of Colombia is likewise declining. Galan No. 1 has been successfully completed, across the river from Shell's Casabe field, which gives heavy oil.

In Ecuador the International Ecuadorean Petroleum Co. has drilled 12 wildcats without making a commercial discovery.

Three of Peru's producing areas are quite old and have had relatively stable production for the past ten years. It is unlikely that any substantial additions to reserves will be made in these areas.

Notes are given on the petroleum industry in Peru and Colombia, from the point of view of Laws, personnel, etc. G. D. H.

**554. The De Mares Concession of Colombia.** G. O. Ives. *Oil Wkly*, 7.1.46, **120** (6), 30 (*International Section*).—In 1944 Colombia produced 22,387,508 brl of oil, all from the De Mares and Barco concessions. The cumulative output was 346,763,808 brl, 95% of this oil had come from the De Mares concession.

The first Colombian production was obtained in 1918 at Infantas on the De Mares concession. 200 brl/day was obtained from the Eocene. The Infantas field is on a faulted anticline, with the productive area running for 7 ml slightly east of north and having a width of 1 ml. Two further producing sands were found in the Oligocene, but these are comparatively unimportant. 452 producers and 20 dry holes have been drilled; 10 have been abandoned, 1 is flowing, 275 are pumping, and the rest are closed in. There is a main overthrust on the eastern boundary of the field, and there are minor east–west cross-faults breaking up the producing area. The average thickness of the producing zone is about 400 ft.

In 1926 the La Cira field was found to the northwest. Its productive area is about 5200 acres. It also is an anticline with an overthrust on the east, but this thrust is towards the west. The same three producing zones occur. 809 wells have been drilled. 697 were producers. Production ranges 500–4500 ft in depth. The top sand occurs in parts only of the two structures. The two structures are operated together. The top zones gives 800 brl/day, the second zone 2000 brl/day, and the bottom zone 42,000 brl/day.

The pipe-line outlet runs to Mamonal near Cartagena.

Several fault-blocks are being repressured with encouraging results.

Tropical's auxiliary activities are described, including the ways in which they care for their employees.

In August Tropical completed Galan 1 on the east bank of the Magdalena. This well is said to have a potential of 1500 brl/day, and is shut in. The oil resembles that of Shell's Casabe field on the Yondo concession, directly across the river. It is on the same structure as Casabe. G. D. H.

**555. Bolivia's Oil Situation.** J. E. Thomas, *Oil Wkly*, 7.1.46, **120** (6), 45 (*International Section*).—In 1937 Bolivia made the oil industry a State monopoly. The early exploration had been in southern Bolivia by the Standard Oil Co. (N.J.). The developed fields are in the extreme south, adjacent to the Argentine fields of the Salta district. The largest field, Bermejo, extends into Argentina, where it is called Agua Blanca. Sanandita and Camiri are the other active fields. Three other fields are marked by single shut-in wells (Caigua, Camatindi, and Buena Vista). A well at Saipuru was plugged because of a lack of market.

Bolivia is land-locked, sparsely populated, and without substantial industry. Domestic markets for oil are small; any substantial production would require a pipe-line across northern Paraguay to give an outlet.

Camiri and Sanandita have small skimming plants of 630–750 brl/day capacity. Most of the Bermejo crude moves to Argentina. In 1944 the average daily outputs of Bermejo, Sanandita, and Camiri were, respectively, 321, 280, and 257 brl. In 1945 the output has increased, and in September the corresponding figures were 618, 310, and 412 brl. Camiri has 5 or 6 wells, Sanandita about 15, and Bermejo 12. A 30-well programme has been planned for Camiri.

There are numerous structures and oil seepages extending northwest to the Peruvian frontier. They lie in a narrow belt—the Sub-Andean Trough. All the seepages seem to be related to very steep folds, usually overthrust. Production is from the Devonian, Permo-Carboniferous, and Tertiary. The Devonian is commonly considered to be the source. Rich looks favourably on the area east and southeast of this belt, and extending eastwards almost to the Brazilian border and south into Paraguay. He expects stratigraphic traps on the eastern flank of this great geosyncline. Drilling is about to be begun in north Paraguay, and this may throw light on these prospects.

Some production and refining statistics are given. G. D. H.

**556. The Middle East—its Present and Future.** C. O. Willson. *Oil Gas J.*, 29.12.45, **44** (34), 183.—General conditions in the Middle East are described, and the operating companies are listed. Proven reserves are estimated at 16,000 million brl, and indicated reserves at 29,250 million brl. Except in Kuwait production is from limestone reservoirs. Kuwait produces from Upper Cretaceous sands, Kirkuk and the fields of

southwest Iran are characterized by extensive jointing which permits uniform drainage with very few wells. The Kirkuk structure is 65 ml long and 2½–3 ml wide. It produces 90,000 brl/day from 10 wells in an area of 8 sq ml at one end of the structure.

In these limestone fields observation wells are drilled to follow the behaviour of the oil–water and gas–oil levels.

Masjid-i-Sulaiman has produced over 750 million brl of crude, and still gives 75,000 brl/day. The residue after topping the crude is now returned to the formation.

Refinery capacity of the Middle East totals 635,000 brl/day, Abadan providing 385,000 brl/day. All the crudes have a relatively high sulphur content. During the war the refineries have been operated to give the largest possible yields of asphalt, residual, fuel oils, diesel oils, and other intermediate products. At Abadan large quantities of 110-octane gasoline were produced. Reforming operations exceeded 100,000 brl/day.

A pipeline outlet is required for the Abqaiq field of Saudi Arabia. A 16-in line is planned to parallel the 12-in lines from Kirkuk to Haifa and Tripoli.

Tables summarize the Middle East field operations, list the refineries, and give the characteristics of the crudes. G. D. H.

## Transport and Storage.

**557. Soil Corrosion and Pipe Protection.** T. H. Gilbert. *Petrol. Engr*, Nov. 1945, **17** (2), 82.—A general discussion is presented on the subject of buried pipelines, their corrosion in the soil, and the various methods employed to shield them from deterioration.

Most soil corrosion is believed to be electrical in character and corrosion on buried metal pipelines is accompanied by an electric current leaving the pipe and flowing into the soil. The main causes bringing about electrical discharge are considered to be :—

(*a*) Stray currents from direct current railways or tramways running near the pipelines ;

(*b*) Natural differences in soil potential may cause currents to flow in the pipe. These currents may be very small and travel only a fraction of an inch, or they may travel for several miles ;

(*c*) Galvanic potentials due to small differences in potential between adjacent particles of iron or mill scale, or between a brass or copper fitting and iron ;

(*d*) Concentration cells due to differences in potential in the soil resulting from variations in the concentrations of gases or salts.

The testing of soil for corrosive properties is discussed and the various available methods are compared. The question of pipeline protection by the use of various coating agents such as asphalt, coal tar, and petroleum waxes in solid form and applied hot is included, and these are compared with the efficiency of various wrapping materials. Methods of electrical inspection of pipeline coatings are also discussed.

Finally, the question of cathodic protection is covered, and full details of the best methods of ensuring this are given.

Numerous diagrams and sketches are included, and a short bibliography is appended. T. M. B. M.

**558. Reconditioning Pipeline under Pressure.** F. H. Love. *Petrol. Engr*, Nov. 1945, **17** (2), 186.—A description of the reconditioning of part of a 10-in pipeline after ten years service in the counties of Reagan, Upton, and Crockett, Texas. The work was carried out by a contracting firm for the Shell Pipe Line Co. The earth covering the buried line is first removed by a conventional ditching machine equipped with a shoe fitting the pipe contour. After uncovering the line, 6 × 4-in. metal straps were welded to the top side of each welded joint for reinforcing. In rocky regions any rock remaining is removed by a tractor-driven plough which has a shoe that fits the top half of the line and rooters which dislodge the rock. The line is then raised from the trench by two sideboom tractors, and supported on skids above the ditch. Three travelling cleaners are used next ; the first has cutting knives and removes most of the old coating, the line is then inspected and repairs noted, and reinforcing straps are welded on the bottom side of each welded joint. The second cleaner then removes the

remaining coating and most of the scale, and then washes the pipe with a cleaning fluid. The third machine cleans the line with steel brushes and applies a primer paint. A travelling-type coating and wrapping machine then applies a coal-tar enamel, and spirally wraps the line with asbestos felt. The ditch is padded with earth in rocky regions, and the line lowered and covered with a 24-in. earth layer. Seven photographs are shown of the machines in operation. W. H. C.

**559. Isothermal Flow of Gases in Pipes.** S. A. Khristianovich, F. A. Trebin, and V. I. Chernikin. *Bull. Acad. Sci. U.R.S.S., Cl. Sci. Tech.*, 1945, 845–856.—The increasing use of large-diameter gas transmission lines, employing high pressures, with a consequent high Reynolds number of the gas passing through, has shown the need for an expression, denoting the flow of gas under such conditions, that shall be more accurate than that of Weymouth (*Trans. Am. Soc. Mech. Eng.*, 1912, **34**, 1090) largely employed hitherto. The expression derived, expressing the gas flow gravimetrically (kg/sec), takes into account the deviation of hydrocarbon gases from Boyle's law and also irregularities in the pipe structure. The gas throughput, and required distance between pumping stations, yielded by the new formula, are less than the corresponding figures obtained by use of the Weymouth calculation. V. B.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**560. Motor Voltage Considerations in Oil Refineries.** E. Kun. *Refiner*, Feb. 1946, **25** (2), 65–66.—An economical evaluation of the voltage to be used in refineries, in American practice and terms, is made. Higher voltages are preferred for high horsepower motors. A. H. N.

**561. Development Work to Prevent Corrosion.** B. B. Morton. *Petrol. Engr*, Nov. 1945, **17** (2), 134.—The planning of development work to prevent corrosion is discussed, and a curve indicative of progress in development work is given showing the relationships time/percentage of progress towards an objective, and is applied in the cases considered. It shows that the evidence of progress occurs some time after the project is launched. This point is considered important to those who must show returns from expensive ventures. The search for superior sucker-rod materials is described. Linings for refinery vessels and plant are discussed, and the necessity for carefully planned economic study is stressed. A test spool for insertion at plant points is described and illustrated. Emphasis is placed on the insulation of test circles against steel, particularly where operations are at temperatures at which water may condense, so as to avoid electrical couples. Brief mention is made of the effects of crudes containing sulphur and naphthenic acids. Preliminary spool tests showed that normal stainless steels were destroyed at a rate higher than for carbon steel, and indicated that a molybdenum variety of 18-Cr, 8-Ni alloy, or Inconel containing 80-Ni, 13-Cr, would have to be used, the Inconel is available as seamless steel tubes. Monel is used for HF, and Hastelloy B (Mo-Ni) for HCl. W. H. C.

**562. Stainless and Heat-Resisting Steels.** J. S. Ewing. *Petrol. Engr*, Feb. 1946, **17**, (5), 124.—Stainless and heat-resisting steels are reviewed from the aspects of their application in the petroleum industry. Broadly, increase of resistance to corrosion of chromium steel alloys is given by alloys containing 6–8%, 12%, and 23% chromium; and resistance to oxidation or scaling at high temperatures depends mainly on the chromium content, although the addition of nickel, and in some cases small amounts of silicon, titanium, and columbium, will provide greater protection against this type of action. For still tubes, transfer lines, vapour lines, heat-exchanger tubes which require strength at elevated temperatures, the alloy must be also ductile for fabrication purposes; 18–8 stainless steel with small amounts of molybdenum, titanium, or columbium are normally suitable; for very severe operating conditions steels with 25% chromium and 20% nickel must be used. Corrosion of refinery equipment is discussed from the aspects of types of processes, deleterious materials in the crudes or products, or elemental gases liberated therefrom, or turbulence through pipes and of

hot-end applications. As no general recommendations can be made for the various applications, types of corrosion and heat resisting steels are discussed under the following sections: bubble caps, bubble trays, liners, valve pumps, weld overlays, miscellaneous hot- and cold-end applications, in which the types of steel alloys suitable for the conditions of operation are discussed. W. H. C.

**563. Turbulent Movement of Liquids in Round Pipes.** V. G. Nevzglyadov, *Bull. Acad. Sci. U.R.S.S., Cl. Sci. Tech.*, 1945, 857–874.—The paper is a theoretical and mathematical consideration of the stationary flow of an incompressible viscous liquid in a smooth-walled straight pipe of circular cross-section. V. B.

## Distillation.

**564. No Peace for Fractionators.** P. J. Harrington, B. L. Braggand, and C. O. Rhys. *Oil Gas J.*, 24.11.45, **44** (29), 135.—Fractionating tower studies by the Standard Oil Co. are described and extensively discussed. They were commenced owing to difficulties arising in two crude-oil pipe-stills at the Bayway refinery in 1941. The main columns were 12½ and 16½ ft in diameter, the units being designed for processing 28,000 b/d East Texas crude to 20% bottoms and 32,000 b/d, West Texas crude to 30% residue, and required reflux and pump-round flow rates up to 115,000 g/hr of hot liquids across the plates. Gaps of 5 to 25° F, based on the 95 and 5% points of adjacent cuts, were expected. The hydraulics of the tower plates were investigated, and are described. From these and other studies, including moving pictures, valuable information was obtained in respect of normal and abnormal flow across the plates which lead to the means for their correction. Very simple changes were possible which permitted increase of throughput up to 45,000 b/d with gaps of 20–35° F continuous cuts, with 100% efficiency. The difficulties encountered are fully described. Briefly they amounted to a resistance to the flow over the plates causing the phenomena termed "dumping," which is due to (*a*) too long a liquid path, (*b*) low cap-pressure drop, (*c*) excessive resistance to liquid flow across the plates.

Dumping differs from flooding. A dumping tower may give no evidence of the phenomena, especially if no large sidestream is taken off, and may even give tolerably good fractionation. The many methods of correcting the cap plates to eliminate dumping are described. At a later date, in another large pipe-still, newly installed, a new trouble was found. At high throughputs a cyclic surging was heard which the early studies could not solve. To investigate this, pyrex observation plates were fitted in the sections, and scales were fixed inside to observe liquid levels and spray heights; moving pictures were also taken. The investigation and results are described, and a diagram shows the counter-current vapour cross flow over plates and the liquid hold-up on the plate inlet side, responsible for the surging. In this case, by blanking caps so as to eliminate counter-current cross flow and arranging the caps so as to reduce spray heights, the plates were made capable of operating without surging at a throughput greater than designed capacity. The knowledge gained was used in designing new stills for processing 30,000 b/d to 16% residue, which when installed could be operated at 50,000 b/d for 18% bottoms, with adjacent cuts of 10–15° F better than the design figure. Some details are given of investigations in respect of isobutane towers, 10-ft-diameter 50 single-pass plate column designed for 7500 b/d of alkylates and butanes, producing 5000 b/d of 80% isobutane overhead, with about 1% of isobutane left in the butanes bottoms. Reflux meters indicated 25–30,000 b/d. but heat and material balances proved that much of the pumpback was being carried over from the tower as liquid. Despite this, the tower ran smoothly and had an over-all plate efficiency as usually defined of 80%. The studies revealed the tower to be badly flooded. High liquid-flow rates had caused gradients across the plates which upset vapour flow and resulted in counter-current vapour cross-flow as outlined above. In this case, however, due partly to a considerable number of transverse plate support beams, vapour cross-flow velocity was so high over much of the plate as to entrain liquid spray upstream. Surging did not occur, as in the re-run still, the build-up of liquid was only limited by filled down-comers. In the 27-in plate spacing it was observed that liquid heights were 12 in over weirs and 25 in on the liquid inlet side, yet smooth operation and fair fractionation were obtained. When the modifications previously described were made,

and also by increasing downcomer to plate clearances, the isobutane tower was able to handle 45,000 b/d of vapour and liquid load with a plate efficiency of at least 106%. Tower-charge hydraulics are briefly reviewed. W. H. C.

## Cracking.

**565. Modern Refining Processes. 2. Catalytic Cracking for Production of Motor Gasoline.** G. A. Armistead. *Oil Gas J.*, 2.3.46, **44** (43), 60.—Catalytic cracking is a new and expensive process, and has to face heavy competition from older processes making similar products.

Its primary advantages over thermal cracking are generally recognized to be: 1. High-quality level of the cracked motor gasoline; 2. Reduced degradation of feed to gas and residuals; 3. Adaptability to high sulphur feed-stocks; 4. Increased gasoline yields from heavy feed-stocks.

The three widely used processes are the Fluid, Thermofor and Houdry, while one Cycloversion unit is in use.

These processes are described and illustrated by schematic flow diagrams.

The general limitations of catalytic cracking units may be classified as: (*a*) reaction; (*b*) carbon burning; (*c*) preparation equipment; (*d*) fractionation; and (*e*) sulphur content of fuel limitations. Each of these factors is considered in detail and its importance evaluated.

It is concluded that carbon burning is the most important limitation to all types of catalytic cracking and will continue to be the major bottleneck.

The characteristics of the motor gasoline produced by these processes are somewhat similar with O.N. varying from 77 to 84 A.S.T.M. and lead susceptibility reflecting the unsaturated quality of the product. High sulphur content of the feed-stock has a depressing effect on O.N. and T.E.L. susceptibility of the cracked product.

D. L. S.

**566. Modern Refining Process (2). Factors Affecting Quality of Motor Gasoline from Catalytic Cracking of Gas Oils.** G. A. Armistead. *Oil Gas J.*, 9.3.46, **44** (44), 76.—Factors are discussed, such as boiling range, aniline number, sulphur content of feed-stock, which materially affect the quality of motor fuels produced by catalytic cracking. Under similar conditions the A.S.T.M. octane ratings may vary from 79 to 82, depending on the charge-stock properties. While the effect of boiling range is less positive than characterization factor, the heavier feed-stocks under the same cracking conditions give products more unsaturated, which tend towards higher C.F.R.-R. octane numbers and reduced lead susceptibility.

The sulphur content of the feed-stock largely controls that of the gasoline, with consequent effect on clear octane and lead susceptibility. When acid treated to remove substantially all the sulphur, some catalytically cracked gasoline in the range of 0·10–0·20% sulphur show very little increase in the clear C.F.R.-M. octane number, although lead susceptibility is considerably improved.

Catalyst type and activity are important factors, synthetic silica–alumina catalysts produce less carbon and more saturated products with higher content of isoparaffin and aromatics than natural-type catalyst under comparable conditions. The activity of a catalyst after prolonged use may have an appreciable effect on quality of motor gasoline.

Operating conditions considerably influence the quality of the liquid products from catalytic cracking, more severe conditions tend to produce a higher-quality gasoline and a more aromatic cycle-oil fraction, but there are definite limitations to the use of high temperatures of this purpose. The increase of C.F.R.-R. clear octane number with temperature is rapid, and leaded octane numbers increase similarly. The effect of temperature on motor octane is much less. Tables illustrate the effect on quality of numerical increase in variables, and give factors affecting quality of catalytically cracked motor gasoline. G. A. C.

**567. Modern Refining Processes. 3. The Coking of Hydrocarbon Oils.** G. A. Armistead. *Oil Gas J.*, 16.3.46, **44** (45), 103.—The coking processes and their utility in the refining industry are reviewed. Thermal coking processes fall into two classes: one for ultimate gasoline yield in which the gas oil evolved is completely cracked, and

the second for partial gasoline yield in which stock is coked and the gas oil produced subsequently cracked in a separate operation.

The de Florez process is an example of the former operation; the feed, ranging from gas oil to heavy cracked tars, is introduced into the primary fractionator, where some distillation takes place, the residue being collected in the tower base for introduction to the coke-drum. Heater feed is passed through the heater under pressures ranging up to 500 lb at temperatures up to 1100° F, the discharge and the primary fractionator bottoms entering the coke-chamber, where the vapours pass overhead, the residual liquid at 800–875° F going to coke. Two or more coking chambers are used alternately, at 25–150 lb pressure. The products are motor gasoline, gas, and coke, conversion per pass to gasoline ranging up to 25%. With very low-gravity feed-stock the process is not economic, the gasoline yield increasing with rising gravity. In the delayed coking process virgin residual feed is coked to partial yields of gasoline with production of gas oil for feed to thermal, or catalytic cracking. In this process the feed is passed through a heating coil, raised to 900–950° F, and discharged into the coking chamber operating at 5–50 lb. pressure and 775–850° F. temperature, where the vapours pass into the fractionator, the unvaporized portion being coked; two or more coking chambers being used alternating. Gas-oil yields increase with increasing A.P.I. gravity, whilst yields of gasoline, coke and gas decrease. The quality of coke produced is important, lighter stocks tend to produce a harder and more compact coke. Topped crudes yields coke of about 7–10% volatile combustible matter and a density of approximately 1·0; and variations in operating conditions yield cokes of differing characteristics.

Coke is removed by either the cable or hydraulic systems. In the former 4000 ft of ¼-in. stranded steel cable, coiled in the chamber from top to bottom, is pulled through the bottom mainway, dislodging the 125 tons of coke as it comes. The hydraulic method is in more general use, and consists essentially of cutting out the coke mass by high-velocity water streams, the removal speed being high, 150 tons being cut out in about 2 hr. A third method involves use of a rotating drill which dislodges the main body of coke by impact and scraping of swinging weights. The process is competitive with viscosity-breaking and cracking with higher yields. G. A. C.

**568. Vapour Phase Oxidizing Cracking of Oil Products,** Part II. L. J. Berents and V. E. Glushnev. *Nat. Petrol. News* (*Tech. Sect.*), 5.12.45, **37** (49), R 1014.—Further evidence is given to support the statement that decomposition of the feed material proceeds the more vigorously the higher the $O_2$ content of the charge within the limits studied. It is postulated that $O_2$ initiates the decomposition of the hydrocarbon chain, and that peroxidic substances formed as a first stage serve as the source of activation and initiation of new chains.

Experiments of oxidizing cracking of gas oil have been carried out in a reaction tube of 5000-ml capacity. Results indicate that the highest yield of aromatics exceeding 11% was obtained at 530–550° C. Gasolines with substantial aromatic content can be obtained, and cracking at 520–550° C yielded 16·6% with an end-point of 150° C and containing 60–65% benzene, touene, and xylene, while if the end-point be extended to 225° C, 22–25% gasoline can be obtained with a content of low molecular aromatics of 47–50° C. The remainder of this gasoline will consist of unsaturated *cyclo*-olefins with 5 and 6 C atoms and dienes.

In the cracking of Surakhany mazut the highest yield of 200° C end point gasoline was 16·8%, with a charging rate of 88·7 gm/hr and temperature of 620° C. The effect of variation in the temperature on the composition of the gasoline has been studied. In none of the experiments was there any appreciable coke deposition.

A theory as to the mechanism of oxidizing cracking is advanced. D. L. S.

**569. Turn-arounds in Fluid Catalytic Cracking Units.** L. R. Hill and J. W. Moorman. *Petrol. Engr*, Feb. 1946, **17** (5), 98.—Extensive information on off-stream periods of fluid catalytic cracking units has been collected by the Kellogg Co in respect of their plants. The data have provided a comprehensive outline of the effects of corrosion, erosion, and mechanical wear of equipment, and are of importance for providing: (1) essential information for efficient operation of units; (2) additional mechanical design information so that improved equipment would result; (3) further information on processing in general, and are useful for determining optimum conditions for any

particular unit. Through the information gained, better design features have been incorporated in succeeding plants, so that to-day fluid catalytic cracking units have stream efficiencies of more than 90% with maintenance costs of less than 4% per year of the investment cost. It is obvious that the stream efficiency factor, *i.e.*, the number of operating days per run, divided by the total number of days run, plus the days required for the turn-around, is a very important consideration in the economics of an operating plant. Before a turn-around is made, a programme of planning and organization is drawn up to enable the turn-around to be made in the shortest time. Full details of such a scheme are given. All key points in the system should be inspected during the shut-down, whether or not experience indicates the necessity. These include: slide valves, principle catalyst carrier lines, tubular equipment through which the catalyst flows, fractionating system, slurry pumps.

Experience has shown that detailed inspection of other equipment and lines is practically unnecessary. A summary is given under the following sections which indicates the conditions of such equipment, and which is useful as a guide: cyclones, regenerators, slide valves, exchangers, fractionators, catalyst piping, expansion joints, feed heaters, waste-heat boilers, and reactors. Details are given and discussed of typical stream efficiencies, distribution of shut-down causes, and typical craft distribution for turn-arounds, turn-around man-hour requirements for both aviation gasoline and motor gasoline producing units. A brief outline is given of the method of starting up after the unit is again ready. W. H. C.

**570. High-Capacity Operations on Fluid Cracking Units.** E. V. Murphree, E. J. Gohr, H. Z. Martin, H. Z. Ogorzaly, and C. W. Tyson. *Nat. Petrol. News* (*Tech. Sect.*), 5.12.45, **37** (49), R. 972.—Methods were developed during the war to improve the output of fluid catalytic cracking plants operating with the maximum amount of carbon burning in the regenerator.

Within the limitations imposed by the carbon-burning capacity, output of such a plant can be increased: (1) by improving carbon conversion relationships; (2) by altering conditions to obtain a greater carbon-burning rate.

Two methods of achieving (1) have been applied: (*a*) improvement of stripper efficiency to reduce hydrocarbon carry-over to the regenerator; (*b*) reduction in the ratio of catalyst to oil feed by raising the regenerator temperatures. It was determined that these temperatures could be raised from 1050–1075° F to 1100–1150° F.

Fresh feed-charge capacity was increased 15–20% by reason of the reduction in carbon yield at the lower catalyst/oil ratio and by the use of a larger proportion of oxygen in regeneration a higher carbon-burning capacity resulted.

The article is furnished with representative plant data to illustrate the results obtained. D. L. S.

**571. Liquid-Charge Technique in T.C.C. Processing.** T. P. Simpson, S. C. Eastwood, and H. G. Shimp. *Nat. Petrol. News* (*Tech. Sect.*), 5.12.45, **37** (49), R. 977.—The catalyst-flow system for liquid-charge technique in T.C.C. processing is essentially the same as for vapour-phase operation, although the rate of catalyst circulation may be somewhat higher. The reactor used is the concurrent solid bed downflow type with provision for introducing the feed at the top and removing the cracked products from the bottom. The charge may consist of total liquid or mixed liquid/vapour, while the catalyst is the same as is used in the present conventional vapour-phase operations.

Experimental work has shown that the catalytic reaction starts and proceeds extremely rapidly the instant the spray meets the catalyst, and it has been demonstrated that in the cracking of a 25% Mid-Continent crude residuum, 70% of the ultimate gasoline formation has occurred at a point representing only 12% of the total path through the reaction zone.

Yields of motor gasoline of 45–60% vol., of distillate fuel 20–30% vol., and of heavy fuel 10–20% vol. are typical. The gasolines have excellent volatility, octane numbers 77–82 with good lead response, while light distillate fuels with low pour points are obtainable.

Catalyst-to-oil ratios of the order of 1·8–4·0 vol. have proved to be adequate, and, to minimize coke laydown, the Conradson carbon of the feed should not exceed 4% wt. Deasphalting should be carried out if the Conradson carbon is too high, and this will improve gasoline yields, besides reducing coke formation. D. L. S.

**572. T.C.C. Unit Turn-around Procedure.** J. B. Godwin and R. B. Kennedy. *Petrol. Engr*, Nov. 1945, **17** (2), 93.—Little has hitherto been published describing the practical aspects of servicing and maintaining the various types of equipment employed in Thermofor catalytic cracking. This article discusses fully the means adopted by the Beaumont refinery of the Magnolia Petroleum Co. to provide efficient utilization of time, labour, and materials to restore the equipment to prompt operation.

A complete account is also included on the procedure adopted for shutting down the plant and preparing the equipment for the maintenance crews. T. M. B. M.

**573. Corrosion Problems in the Cracking of Shale Oil.** G. E. Mapstone and C. B. McLaren. *Refiner*, Feb. 1946, **25** (2), 49–52.—On cracking, the tar bases in crude shale oil give rise to small amounts of hydrogen cyanide. In the presence of water and ammonia, part of the hydrogen cyanide is hydrolyzed to formic acid, the remainder combining with the iron products of corrosion to form prussian blue. The formic acid causes corrosion in the upper section of the pressure distillate stabilizer, while in other sections of the plant the presence of tar bases inhibits this form of corrosion. Installation of a countercurrent caustic-soda wash between the distillate receiver and the stabilizer effects satisfactory removal of the acidic corrosive materials. A. H. N.

## Absorption and Adsorption.

**574. Diethylene Glycol Plant Dehydrates Gas to Exact Specification.** Anon. *Refiner*, Feb. 1946, **25** (2), 67–68.—A brief description of a plant using diethylene glycol for dehydration of gas is described. A flow sheet is presented and the process outlined. A. H. N.

## Alkylation.

**575. Results of Alkylation Plant Modification.** J. H. Kunkel. *Petrol Engr*, Nov. 1945, **17** (2), 168.—The increased production through modification to the Bayway refinery catalytic cracking plant, which has no alkylation facilities (see Abstr. 1329–1945), has necessitated modification of the Baltimore refinery's alkylation plant to accommodate the increased supply received from Bayway. The alkylating unit at Baltimore was designed to process 4190 brl/day of butenes only, consuming 50 ton/day of acid, for the production of 2130 brl/day of depentanized aviation alkylate, having an A.S.T.M. Motor method octane value of 93, with F.B.P. of 350° F, 120 brl/day of heavy alkylate; and 40 brl/day isobutane. The modifications required are described by which the plant was enabled to alkylate 11,500 brl/day, consisting of 9000 brl/day of $C_4$ and 2500 brl/day of $C_5$ hydrocarbons, to give 4055 brl/day of aviation alkylate of A.S.T.M. Motor method octane number 88·7 with a 370° F end point; 630 brl/day of heavy alkylate; and 900 brl/day of isopentane; the acid consumption being 320 tons/day. Briefly the alterations required additional pumping facilities, more heat exchangers, larger condensing capacity, and fractionating column revision. The feed-nozzles on the isobutane tower were placed nearer the top to improve stripping, and to improve fractionation the down-spout clearances to the plates were increased and the bubble-cap blanking was revised. The tower pressure control was changed and re-positioned to permit a lower cooling temperature in the condensers and to reduce dezincification of the condenser tubes. A larger feed line to the re-run tower was put in to reduce the load on the stripper in the base of the tower. To ease the load on the re-run column and to facilitate blending of the final gasoline product, which contains large amounts of isopentanes, an off-site depentaniser in the refinery's thermal cracking unit was tied in with the plant between the butane tower and the re-run tower. In this revision of flow, butane-tower bottoms enter the depentanizer for a close-cut separation of the $C_5$s. The depentanizer's overhead isopentanes is condensed and goes to storage for blending, and the tower bottoms, depentanised total alkylate, are charged to the re-run tower preheater. The reactor temperature is maintained at 58° F instead of 35–40° F as in the original plant. W. H. C.

**576. Corrosion by Hydrofluoric Acid.** U.Z. Friend and H. O. Teeple. *Oil Gas J.*, 16.3.46, **44** (45), 87.—The results of laboratory and plant corrosion tests in hydrofluoric acid of various concentrations are recorded.

In the alkylation process hydrofluoric acid or fluorides initially enter the system in the anhydrous form, but water may be picked up from feed materials or leakage, and corrosion by dilute solutions is set up.

Laboratory corrosion tests were made in metal containers, Monel, nickel, or lead for the dilute solutions and Monel or steel for the concentrated solutions; the test specimens being completely immersed and not in contact with the container or other metals.

Corrosion tests were also made in various parts of the regeneration equipment of alkylation plants, such as the top of the acid-regeneration column and in the inlet and outlet ends of its preheater. Tests were also made in hydrofluoric acid solutions in operating equipment in plants using this acid for other purposes, *e.g.*, in the acid pickling solutions used for the pickling of cast iron. From the data given in tables, general conclusions as to the performance of common metals and alloys in hydrofluoric acid have been drawn.

Monel metal is usefully resistant to all concentrations of the acid, including anhydrous acid over a considerable range of temperature. Its corrosion rate may be increased by a high degree of aeration of the solution, and by the continuous presence of oxidizing salts such as cupric or ferric salts. Monel is not subject to stress-corrosion cracking in hydrofluoric acid, but it is in strong fluosilicic acid solutions containing 22% $H_2SiF_6$. This may be prevented by stress-relieving Monel vessels. The corrosion rates for "K," "H," and "S" Monels are similar to those for Monel itself. Copper and high-copper alloys, such as red brass, silicon bronze, and admiralty brass, are equal in their performance in hydrofluoric acid; in dilute solutions corrosion rates are considerably increased by aeration or oxidizing salts. The upper temperature limit appears to be 175° F. Copper–nickel alloys are next to Monel in general performance. Carbon steel is resistant to concentrations above 75–80% up to about 150° F, so that it can be used in most of the equipment except that involved in acid regeneration, and sufficiently large clearances should be allowed in plug-valves for scale formation. Nickel, Inconel, Hastelloy alloys, austinitic stainless steels, and other alloys are also studied, and corrosion rates in inches per year for all materials tested are given in 9 tables.

G. A. C.

## Chemical and Physical Refining.

**577. Fullers Earth as a Binder for Catalysts and Adsorbents.** R. G. Capell, R. C. Amero, and W. H. Wood. *Refiner*, Feb. 1946, **25** (2), 69–71.—The characteristics of fuller's earth in general, and of "Florigel" in particular, as binders are discussed. It is concluded that Florigel is eminently suitable because: (1) when mixed with water and catalytic or adsorptive materials, it forms a plastic mass which may be readily mixed, pugged and extruded, pressed or pelleted; (2) it gives increased mechanical strength to a wide variety of soft non-plastic materials; (3) it is irreversible with respect to water—that is, it does not "mud-up" or break down after heating at 700° F or higher, and therefore preserves its binding action in contact with water or steam; (4) it is a porous, insoluble mineral, and therefore does not "bind-off" or detract from the surface area of the material being bound; (5) it is an adsorbent and a catalyst in its own right, and active in decolorization, polymerization, desulphurization, and dehydration reactions; (6) it is stable at high temperature. A. H. N.

## Special Processes.

**578. Patent Trends in Petroleum Refining.** P. J. Gaylor. *Nat. Petrol. News* (*Tech. Sec.*), 5.12.45, **37** (49), R. 986.—*Nitro-Hydrocarbons and Derivatives.* The patents dealing with the preparation of nitro-hydrocarbons by the reaction of $N_2O_4$ with the lower paraffins and olefins are discussed. Thus 1 : 2-dinitro-ethane, melting point 39–40° C and boiling at 135° C/5 mm, is produced by reacting ethylene and $N_2O_4$ at −10° C and atmospheric pressure. The percentage of ethylene in the mixture must be kept within definite limits to avoid danger of explosion.

*iso*-Butylene also reacts to form 1 : 2-dinitro-2-methylpropane.

A number of these patents is held by the I.C.I., Ltd.

*Bead Catalysts.* Socony Vacuum's patents on "T.C.C. synthetic beads" involve the dropping of hydrosol catalyst globules into a fluid immiscible with water (such as

oil) in which the globules assume a spheroidal shape. Gelling takes place at the interface between the sol and the medium

One of the peculiar features attributed to these gel pellets is their transparency, present only when silica is predominant. They are extremely hard, and are thus capable of resisting losses by attrition and shock due to handling.

*Vinyl Acetylene.* This is the raw material for neoprene, and can be produced by the controlled polymerization of acetylene. A patent has been taken out by Phillips Petroleum for the recovery of this material from a $C_4$ stream from certain thermal cracking and catalytic dehydrogenation processes.

An azeotropic exists between vinyl acetylene and butenes 2 which is of minimum boiling point, and can thus be separated by distillation. A number of solvents have been found which selectively absorb vinyl acetylene from the other $C_4$ hydrocarbons and render it possible to obtain it in purity of 95%.

In the production of butadiene by pyrolysis of hydrocarbons the $C_4$ fraction is usually extracted with ammoniacal cuprous acetate solution, in which the diolefin is selectively absorbed. Acetylenes are also absorbed forming acetylides, but these can be separated, since they are very soluble in high ammonia or high amine solutions.

*Acrolein Compounds.* The oxidation of olefins to acroleins by the use of tellurite and selenite catalysts is the basis of a new patent. D. L. S.

**579. New Version of Fischer–Tropsch Reaction gives 90% Yields of iso-Paraffins.** V. Haensel. *Nat. Petrol. News.* (*Tech. Sect.*), 5.12.45, **37** (49), R. 955.—This is the report of an Oil Mission team to Germany, and deals with work carried out at the Kaiser Wilhelm Institut für Kohlenforschung, Muelheim Ruhr. By modifying the composition of the synthesis gas for the Fischer–Tropsch reaction so as to obtain a 20% excess of CO over $H_2$, it is possible to produce a product containing an excess of iso-paraffins.

The reaction first produces higher alcohols (primarily isobutanol), which are then dehydrated, and the resulting olefins hydrogenated to the iso-paraffins. One step synthesis was achieved by combining all three reactions into one stage.

A number of catalysts have been developed which are suitable for this reaction, mainly consisting of the oxides of zinc, thorium, or aluminium, or mixtures of these. The reaction is carried out at 450° C and 300 atm pressure, and the throughput is 5–10 times higher than that used in the regular process. D. L. S.

## Metering and Control.

**580. Selection and Application of Refinery Instruments. Part 2. Temperature.** A. Krieg. *Petrol. Engr*, Feb. 1946, **17** (5), 74.—The three basic types of instruments used in temperature measurement or control are: (*a*) thermometer or thermal bulb type; (*b*) potentiometer pyrometer or thermocouple type; (*c*) resistance thermometer or resistance bulb type. In section (*a*) thermal bulb types are classified as: liquid expansion; vapour tension; gas filled; mercury filled.. In section (*b*) potentiometer pyrometers are described under the headings: electrochemical potentiometer; electronic potentiometer; electronic photo-tube potentiometers. In section (*c*) resistance thermometers are described and discussed under two arrangements for circuit balancing—viz., mechanically balanced and electronically balanced thermometers. The instruments indicated in the sub-sections are described and discussed in respect of their characteristics, range of scale, accuracy, permissible length of tubing (for type (*a*)), suitability for various types of plant. Process variables are outlined and discussed from the aspects of capacity lag, transfer lag, and distance lag. Sections on thermal potential and furnace outlet control are also given. W. H. C.

**581. Effect of Measurement Dead Time in Control of Certain Processes.** D. P. Eckman. *Petrol. Engr*, Feb. 1946, **17** (5), 59.—One of the most important factors in automatic control of processes is the manner in which the controller mechanism responds to changes in the measured variable. This measuring lag forms an extensive part of the input–output controller relationship. Investigations of the factors of measurement of dead time and dead zone in automatic control instruments have been made with a view to aiding the application of theoretical and empirical data to control problems.

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The measuring lag of a temperature controller is composed of : (1) the lag of the primary element ; and (2) the lag of the controller detecting mechanism. For the purpose of these studies, two classes of self-balancing potentiometer controllers are discussed : (*a*) a periodic action, and (*b*) a continuous action, potentiometer. In the periodic type instrument, when an unbalance of voltages is produced by a change in measured temperature the detecting mechanism determines the amount of unbalance and drives a voltage divider or slide wire to balance against the new value of measured voltage. The continuous type of action potentiometer uses a continuous uninterrupted drive (usually electronic) to obtain the balance measured against standard voltages. The use of continuous action in potentiometer balancing eliminates any lag due to a rebalancing mechanism, and avoids periodicity, whereby a small dead time may elapse before changes in controller temperature can be detected. In order to determine the effects of dead time in the measuring system, the following tests are described and discussed : (*a*) two-position control, by which all extraneous factors may be eliminated from the tests on automatic control ; (*b*) proportional reset control. A controller may be applied to a process, and the deviation during a recovery from a load change may be expected to show differences depending on the magnitude of the dead zone. The dead zone is usually defined as the greatest range of scale values within which changes in the value of the controlled variable are not detected. The results given show the importance of measuring lag and measurement dead zone in automatic control. It is desirable to maintain measurement dead time as small as possible, for it increases the quality of control, especially on those processes where all other lags are small. By keeping dead zone small, a reduction of dead time is obtained which increases quality of control.
W. H. C.

**582. Rotameters.** W. J. Beckett. *Refiner*, Feb. 1946, **25** (2), 91–93.—The principles of construction and use of rotameters are given in this paper, which forms a part of Southern California Meter Association Meter Course. A. H. N.

## PRODUCTS.

### Chemistry and Physics.

**583. The Oxidation of Liquid Hydrocarbons. I. The Chain Formation of Hydroperoxides and their Decomposition.** P. George, E. K. Rideal, and A. Robertson. *Proc. Roy. Soc. A.*, 14.3.46, **185**, 288.—The course of the low-temperature liquid-phase oxidation of hydrocarbons through hydroperoxide formation and subsequent decomposition has been confirmed. The function of a heavy metal catalyst is to increase both the rate of formation and decomposition of this hydroperoxide. The dependence of the stationary concentration of hydroperoxide on the oxidation rate and the catalyst concentration indicated that the hydroperoxide decomposition is unimolecular with the reaction velocity constant directly proportional to the catalyst concentration. This has been confirmed by independent decomposition experiments. It is suggested that the reaction involves the breakdown of a "heavy metal catalyst-hydroperoxide" complex.

From a study of the oxidation rates of hydrocarbons, alcohols, and ketones, and the oxidation of mixtures, it was found that alcohols are the most resistant to oxidative attack, and, furthermore, inhibit the catalysed oxidation of long-chain paraffins. The oxidation cannot therefore proceed through alcohols as primary intermediates, and the hydroxylation theory is thus inapplicable to these liquid-phase oxidations. It is suggested that the sequence hydrocarbon–hydroperoxide–ketone represents the major course for the reaction in the early stages of the oxidation.

From the variation of the inhibited rate with time, a theoretical treatment has enabled the chain length of the uninhibited oxidation to be determined. For instance, at 120° C the chain length is $142 \pm 10$. The "activation energy" of the chain length is $-13{\cdot}3 \pm 2$ k cal. : thus at 20° C the chain length would have a value of 48,000. From this activation energy and that of the overall reaction, the activation energy of the chain initiation reaction has been found to be $28{\cdot}2 \pm 2{\cdot}5$ k cal.

In the heavy-metal catalyzed oxidation the rate is independent of the catalyst concentration above a certain value. This may be explained by the hypothesis that the

heavy-metal catalyst both starts and stops reaction chains responsible for hydroperoxide formation. The phenomena of positive and negative catalysis follow, according to relative efficiency of the heavy-metal catalyst in these two reactions.
T. M. B. M.

**584. The Oxidation of Liquid Hydrocarbons. II. The Energy-Chain Mechanism for the Thermal Oxidation of Tetralin.** P. George and A. Robertson. *Proc. Roy. Soc. A*, 14.3.46, **185**, 309.—The liquid-phase oxidation of hydrocarbons, where the point of the oxidative attack is a $>CH_2$ group, has been shown to proceed at a rate independent of the oxygen pressure and proportional to the square of the hydrocarbon concentration. This arises from a primary chain reaction which gives a hydroperoxide as the primary intermediate. Degenerate chain branching, resulting from the decomposition of the hydroperoxide, is responsible for a slow exponential increase in the reaction rate with time: it is less marked the higher the temperature.

At the reaction temperatures employed (65–120° C) the hydroperoxide is the predominant oxidation product, and the major kinetic problem has been to determine the nature of the primary reaction chain. An examination of the kinetic characteristics of the inhibited oxidation has shown that the normal chain termination is a unimolecular reaction of the chain carrier, and further, that the chains are initiated in a unimolecular reaction of the hydrocarbon. These conclusions enable a unique choice to be made in favour of an energy-chain mechanism.

In this case the process of inhibition must not only be regarded as an additional means of terminating the reaction chain, but as a competition between the hydrocarbons and the inhibitor for the chain carrier in which the reaction with the inhibitor is greatly favoured.
T. M. B. M.

**585. The Oxidation of Liquid Hydrocarbons. III. The Oxidation of Tetralin in the Presence of Benzoyl Peroxide as a Free Radical Chain Reaction.** P. George. *Proc. Roy. Soc. A.*, 14.3.46, **185**, 337.—The product of the benzoyl peroxide sensitized oxidation of tetralin is the hydroperoxide as it is in the thermal and heavy metal catalysed oxidations. There is clear evidence that the reaction has a chain mechanism. As the concentration of benzoyl peroxide is increased the oxidation rate rises to a constant value, which shows that the peroxide both initiates and terminates the reaction chains. The oxidation rate is proportional to the first power of the tetralin concentration, and is characterized by a complex less than first-order variation with the oxygen pressure over the entire range of peroxide concentrations. This arises from a chain termination reaction with oxygen, a new feature in liquid-phase oxidations, and one which is not present in the thermal oxidation. In view of the accepted free radical character of the benzoyl peroxide decomposition, this oxygen termination reaction is thought to be characteristic of a free radical chain oxidation. A suggested mechanism gives an expression for the rate identical with that obtained from the kinetic investigation.

By using low peroxide concentrations it has been found that the thermal energy chains and the induced free radical chains proceed simultaneously.

Decomposition experiments have shown that in oxidizing systems benzoyl peroxide decomposes faster than in solvents in the absence of oxygen. Using this and other kinetic data, the oxidation chain length has been found to be approximately 230.
T. M. B. M.

**586. Compressibility of Liquid Hydrocarbons.** E. W. Jacobsen, E. E. Ambrosius, J. W. Dashiell, and C. L. Crawford. *Oil Gas J.*, 23.3.46, **44** (46), 109.—The relation of compressibility to A.P.I. gravity for 19 purified hydrocarbons and oils is considered, and compressibility factors for these are given at several temperatures between 30° and 130° F. A list of references to the literature is appended.
T. M. B. M.

**587. Combustion of Liquids from a Free Surface.** G. N. Khudyakov, *Bull. Acad. Sci. U.R.S.S., Cl. Sci. Tech.*, 1945, 1115–1126.—A study was made of the combustion of various liquids, including petroleum products, from the open surface of a quartz vessel (62 mm diam). Once established, the combustion rate remains constant. Measurement of temperature distribution in the liquid beneath the burning surface indicates that there is no appreciable diffusion of heat down into the bulk of the liquid. The

velocity of combustion is increased by pre-heating of the liquid. The thermal potential of the evaporating surface is a constant, which is characteristic for each substance; for the liquids examined it varied from 8580 (ethyl acetate) to 22,920 (green oil) cals./m²/hour. Petroleum products lay in the range 10–12,000 cals./m²/hour. V. B.

**588. The Mechanism of the Alkylation of Paraffins.** L. Schmerling. *J. Amer. chem. Soc.*, 1945, **67**, 1778–1783.—Evidence is presented in support of a chain mechanism for the alkylation of iso-paraffins with olefines.

It is suggested that the *t*-alkyl ester first formed from the iso-paraffin, by addition to the olefine, yields an ester of higher molecular weight, which then reacts with the iso-paraffin to give the observed paraffin product and a new molecule of the *t*-alkyl ester, which then reacts with olefine as in the second step, and thus the cycle is repeated. J. H. P.

**589. The Catalytic Dehydrocyclization of Paraffins.** H. Steiner. *J. Amer. chem. Soc.*, 1945, **67**, 2052–2054.—Experiments on the poisoning of the catalysts used in this reaction and particularly the conclusions drawn regarding the mechanism of the catalytic action are discussed.

It is held that the reaction proceeds by two stages; the dehydrogenation of the paraffin to olefine being followed by the cyclization of the olefine to an aromatic. Both stages are affected by the poisoning of the catalyst. Where the poisoning is due to accumulation of polymer, the two reactions are affected to much the same extent. When water and particularly ethylene is the poison, the dehydrogenation reaction rate is repressed even more than that of the cyclization stage but the decline is still parallel. The author argues, in contradiction to other workers, that the close relationship revealed by the parallel effect of poisons on both reaction rates shows that they proceed on identical centres of the catalyst surface. J. H. P.

**590. The Mechanism of Paraffin Isomerization.** H. S. Bloch, H. Pines and L. Schmerling. *J. Amer. chem. Soc.*, 1946, **68**, 153.—A sequence of reactions is proposed for the isomerization of paraffin hydrocarbons in the presence of an aluminium halide catalyst :—

Eqn. 1. $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3 + \overset{+}{R} \xrightarrow[HCl]{AlCl_3} CH_3{\cdot}\overset{+}{C}H{\cdot}CH_2{\cdot}CH_3 + RH$

Eqn. 2. $CH_3{\cdot}\overset{+}{C}H{\cdot}CH_2{\cdot}CH_3 \rightleftharpoons CH_3{\cdot}\underset{CH_3}{CH}{\cdot}\overset{+}{C}H_2 \rightleftharpoons CH_3{\cdot}\overset{+}{\underset{CH_3}{C}}{\cdot}CH_3$

Eqn. 3. $CH_3{\cdot}\overset{+}{\underset{CH_3}{C}}{\cdot}CH_3 + CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3 \rightleftharpoons CH_3{\cdot}\underset{CH_3}{CH}{\cdot}CH_3 + CH_3{\cdot}\overset{+}{C}H{\cdot}CH_2{\cdot}CH_3$

The chain initiating ion $\overset{+}{R}$, which need be present in small amounts only, may be produced in several ways—*e.g.*, by the addition of hydrogen chloride or hydrogen aluminium chloride to an olefine present in the paraffin as impurity, or which is added as such. The rearrangement of the *s*-butyl carbonium ion (Eqn. 2.) is analogous to that of olefines in the presence of acidic substances, whilst the reaction of Eqn. 3 and of Eqn. 1 is similar to the hydrogen–halogen interchange which occurs between iso-paraffins and *s*- or *t*-alkyl chlorides in the presence of aluminium chloride. Higher temperatures or otherwise more severe reaction conditions are necessary for the isomerization of *n*-paraffins than for the alkylation of iso-paraffins. The proposed mechanism is also applicable to the isomerization of cyclo-paraffins. J. H. P.

**591. Addition of Carbon Tetrabromide and Bromoform to Olefines.** M. S. Kharasch, E. V. Jensen, and W. H. Urry. *J. Amer. chem. Soc.*, 1946, **68**, 154–155.—The addition reaction between carbon tetrabromide and an olefine is initiated either by diacyl peroxides or visual light, and mono-addition products normally result. The reaction with bromoform is extremely slow in the absence of the peroxide. J. H. P.

**592. Catalytic Alkylation of Chlorobenzenes.** G. Vermillion and M. A. Hill. *J. Amer. chem. Soc.*, 1946, **68**, 190–191.—The reaction of cumene with monochlorobenzene

catalysed by aluminium trichloride was studied as a new method of alkylating halobenzenes. The paraisomer is present among the chlorocumenes thus prepared. J. H. P.

**593. Condensation of Aliphatic Alcohols with Aryl Hydrocarbons in the Presence of Chlorosulphonic Acid.** W. H. C. Rueggeberg, M. L. Cushing and W. A. Cook. *J. Amer. chem. Soc.*, 1946, **68**, 191–192.—Alkylated benzenes may be prepared by the slow addition of 1 mole. chlorosulphonic acid to a mixture of 1 mole. of the alcohol and 3 moles. of the aromatic hydrocarbon at about 10°. Secondary and tertiary alcohols react smoothly, but primary alcohols in general do not. The mechanism of the reaction is discussed. J. H. P.

**594. Exchange of Hydrogen and Chlorine between *Bicyclo*-(2 : 2 : 1)-Heptane and *t*-Butyl Chloride.** L. Schmerling. *J. Amer. chem. Soc.*, 1946, **68**, 195–196.—When *bicyclo*-(2 : 2 : 1)-heptane is contacted with *t*-butyl chloride at 0° in the presence of aluminium chloride, 2-chloro*bicyclo*-(2 : 2 : 1)-heptane results, and not 1-chloro-*bicyclo*-(2 : 2 : 1)-heptane, as would be expected. J. H. P.

**595. Freezing Points and Polymorphism of the Eight $C_9H_{12}$ Alkylbenzenes.** A. E. Hirschler and W. B. M. Faulconer. *J. Amer. chem. Soc.*, 1946, **68**, 210—213.—Each of the eight isomeric $C_9H_{12}$ alkylbenzenes has been prepared and the physical properties investigated. J. H. P.

**596. The Ternary System : *t*-Butyl Alcohol, Benzene, and Water at 25°.** D. R. Simonsen and E. R. Washburn. *J. Amer. chem. Soc.*, 1946, **68**, 235–237.—The ternary system tertiary butyl alcohol, water, benzene has been studied, and the solubility curve, refractive index, specific gravity, and relative viscosities recorded and compared with those of the corresponding alcohol, water, benzene system. J. H. P.

**597. Reaction of Methyl*cyclo*pentane with Olefines in the Presence of Sulphuric Acid and Hydrogen Fluoride Catalysts.** H. Pines and V. N. Ipatieff. *J. Amer. Chem. Soc.*, 1945, **67**, 1631–1638.—The reaction apparently involves the following : the addition of methyl*cyclo*pentane to olefines accompanied by ring expansion and migration of alkyl groups within the ring ; hydrogen disproportionation ; isomerization of straight-chain olefines to iso-olefines followed by hydrogenation ; reaction of partly dehydrogenated naphthene with *cyclo*-olefines or saturated cyclic hydrocarbons to form polycyclic olefines or polycyclic saturated hydrocarbons ; depolymerization and/or depolyalkylation. J. H. P.

**598. The Addition of Fluorine to Double Bonds.** A. L. Henne and T. P. Waalkes. *J. Amer. chem. Soc.*, 1945, **67**, 1639–1640.—Fluorine released by the spontaneous decomposition of lead tetrafluoride produced in the presence of excess of an olefine from lead dioxide and hydrogen fluoride may be taken up at an olefinic double bond.

The possibilities of the reaction in furthering the synthesis of symmetrical compounds such as CHClFCHClF are discussed. J. H. P.

**599. Physical Properties of Thiophene,** F. S. Fawcett and H. E. Rasmussen. *J. Amer. chem. Soc.*, 1945, **67**, 1705–1709.—The following properties of thiophene have been determined on a sample freed from benzene and other impurities : f.p., b.p. over the range 500–900 mm., $n_D$, $d_4$, and $\eta$ at 20°, 25°, and 30°, specific dispersion at 20°, and some derived constants. For the system thiophene–benzene the $n_D^{20}$, $d_4^{20}$, $\eta 20$, and f.p. were determined as a function of the composition.

The purification of the thiophene is described, both physical and chemical methods being employed. Analyses were made using a mass spectrometer, which method permits of the detection of as little as 1 part of benzene in 7000 parts of thiophene (and vice versa). J. H. P.

**600. The Reaction of Phenanthrene with Ethyl Diazoacetate.** N. L. Drake and T. R. Sweeney. *J. Org. Chem.*, 1946, **11**, 67–74.—The addition of ethyl diazoacetate to an ethylenic linkage yields a pyrazoline carboxylic ester, which evolves nitrogen at elevated temperatures and forms a derivative of ethyl *cyclo*propanecarboxylate. The reaction has been extended to aromatic hydrocarbons such as benzene, naphthalene, mesitylene,

durene, and, in the present work, to phenanthrene. If the nature of the aromatic precludes addition to a non-substituted carbon atom, a rearrangement product of the bicyclic ester is obtained, and not the bicyclic ester itself. The product in the case of phenanthrene is ethyl dibenznorcaradienecarboxylate, the structure of which is proved; the properties of the acid are described. C. N. T

**601. Phenylation of Some Hydrocarbons with a Phenyl Halide Activated by an Alkali Amide.** R. A. Seibert and F. W. Bergstrom. *J. Org. Chem.*, 1945, **10**, 544–550.—A number of factors influencing the following type of reaction, reported by Wright and Bergstrom (*J. Org. Chem.*, 1936, **1**, 179), have been studied, although no improvement in the yield was effected :—

$$(C_6H_5)_3CK + C_6H_5Cl \xrightarrow[\text{liquid } NH_3]{KNH_2 \text{ in}} (C_6H_5)_4C + KCl.$$

The mechanism of the catalytic effect of alkali amides is unknown, but a number of possibilities have been suggested. Potassium amide, although having approximately the same catalytic effect as sodium amide, gives slightly better yields of tetraphenylmethane owing to its greater solubility in liquid ammonia. Chlorobenzene appears to be the best halide for the reaction : the fluoro-compound does not react under the conditions used, the bromo-compound has a rather high freezing point, whilst the iodo-compound gives rise to extensive tar formation.

Many hydrocarbons having two or three groups attached to a methane carbon atom, and which are capable of forming salts with the alkali amides, can be catalytically phenylated in accordance with the general procedure. For example, diphenylmethyl-potassium is phenylated to tri- and tetra-phenylmethane, 9-fluorylpotassium to 9-phenylfluorene and 9 : 9-diphenylfluorene, and 9-phenyl-1 : 2-benzofluorylpotassium to 9 : 9-diphenyl-1 : 2-benzofluorene. Attempts to replace the K of $(C_6H_5)_3CK$ with aryl groups other than phenyl have so far met with failure.

Potassium amide reacts with bromobenzene in *cyclo*hexylamine to form *cyclo*hexylaniline and a substance which appears to be *cyclo*hexyldiphenylamine.
C. N. T.

**602. Fundamentals of Consistency and Viscosity.** Part 3. J. J. Bikerman. *Refiner*, Feb. 1946, **25** (2), 72–78.—In this concluding part thixotropy and the effect of temperature on consistency are discussed. Different incidental methods of testing for consistency are described at the end of the paper. A. H. N.

**603. Molecular Weights of Viscous Hydrocarbon Oils : Correlation of Density with Viscosities.** A. E. Hirschler. *J. Inst. Petrol.*, March 1946, **32** (267), 133–161.—Molecular weights of lubricant fractions have been correlated with kinematic viscosities at 100° and 210° F., using a modified Keith and Roess chart; and with the density at 25° C. and viscosity at 210° F. By combining these two charts a correlation between these four physical constants is developed whereby any two may be used to estimate values of the other two. Based on this chart, a simple equation has been developed for calculating the molecular weight from viscosity data, applicable to oils with viscosity indices between −50 and 120. Using published data on lubricant fractions, and synthetic hydrocarbons in the lubricant range, these correlations are evaluated and compared with previously proposed correlations of molecular weights with viscosity data; the accuracy of the latter is shown to be quite dependent on the viscosity–temperature behaviour of the oils. The data on synthetic hydrocarbons indicate that the viscosity–density correlations are much more sensitive to composition than the viscosity correlation; the latter is therefore recommended when two viscosities are available. Consideration of a large number of lubricant fractions indicate that the average composition is sufficiently uniform that the viscosity–density correlations will give satisfactory results in most cases; very naphthenic samples should, however, not be evaluated on the viscosity–density charts, unless they are especially prepared for this class of oils. The correlation may be used to estimate $vis_{100}$, $vis_{210}$, or density, given two of the three constants; the accuracy possible for oils of different origins is indicated. A. H. N.

**604. Thermodynamic Properties of Solid and Liquid Ethylbenzene from 0° to 300° K.** R. B. Scott and F. G. Brickwedde. *Bur. Stand. J. Res. Wash.*, Dec. 1945, **35**, 501.—

The following properties of a sample of high-purity ethylbenzene were measured: (1) specific heat of solid and liquid from 15° to 300° K; (2) triple-point temperature (−95·005 ± 0·010° C for pure ethylbenzene); (3) heat of fusion (86·47 int. j $g^{-1}$); (4) heat of vaporization at 294° K (400·15 int. j $g^{-1}$); and (5) vapour pressure from 273° to 296° K. With these experimental data, the enthalpy and entropy of the solid and of the liquid in the range 0° to 300° K were calculated. T. M. B. M.

**605. Heats, Equilibrium Constants, and Free Energies of Formation of the Acetylene Hydrocarbons through the Pentynes to 1500° K.** D. D. Wagman, J. E. Kilpatrick, K. S. Pitzer, and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, Dec. 1945, **35**, 467.—Values are presented for the following thermodynamic properties for acetylene, propyne (methylacetylene), 1-butyne (ethylacetylene), 2-butyne (dimethylacetylene), 1-pentyne (*n*-propylacetylene), 2-pentyne (methylethylacetylene), and 3-methyl-1-butyne (isopropylacetylene), in the gaseous state, to 1500° K: the heat-content function, $(H^\circ - H^\circ_0)/T$; the free-energy function, $(F^\circ - H^\circ_0)/T$; the entropy, $S^\circ$; the heat content, $H^\circ - H^\circ_0$; the heat capacity, $C^\circ_p$; the heat of formation from the elements, $\Delta Hf^\circ$; the free energy of formation from the elements, $\Delta Ff^\circ$; and the logarithm of the equilibrium constant of formation from the elements, log 10 Kf.

Equilibrium constants and concentrations of components are given in tabular and graphical form for the isomerization of the two butynes and if the three pentynes as a function of temperature to 1500° K. Equilibrium constants are also given in tabular and graphical form for the dehydrogenation of ethane to ethylene to acetylene, of propane to propylene to propyne, of *n*-butane to 1-butene to 1-butyne, and of *n*-pentane to 1-pentene to 1-pentyne. T. M. B. M.

**606. The Heat Capacity and Entropy, Heats of Fusion and Vaporization and the Vapour Pressure of Butene −1. The Zero Entropy of the Glass; the Entropy of the Gas from Molecular Data.** J. G. Aston, H. L. Fink, A. B. Bestul, E. L. Pace, and G. J. Szasz. *J. Amer. chem. Soc.*, 1946, **68**, 52–57.—Butene-1 has been crystallized for the first time and thermal data obtained down to 11·5° K. The calorimetric entropy of the ideal gas has been used in conjunction with assumed molecular data, to calculate two alternative values of the barrier hindering the mutual relative rotation of the ethyl and vinyl groups. J. H. P.

**607. The Heat Capacities, Heats of Transition, Heats of Fusion and Entropies of *cyclo*-Pentane, Methyl*cyclo*pentane and Methyl*cyclo*hexane.** D. R. Douslin and H. M. Huffman. *J. Amer. chem. Soc.*, 1946, **68**, 173–176.—Heat capacity data on *cyclo*pentane, methyl*cyclo*pentane and methyl*cyclo*hexane have been obtained over the range 12 to 300° K. Melting points and transition temperatures, heats of fusion and transition determined and entropy values for the liquid state at 298·16° K were calculated J. H. P.

**608. Physical Chemical Properties of the 2 : 3-Butanediols.** J. W. Knowlton, N. C. Schieltz, and D. Macmillan. *J. Amer. chem. Soc.*, 1946, **68**, 208–209.—The diastereoisomeric 2 : 3-butane diols have been obtained in a high degree of purity and their physical properties investigated. J. H. P.

**609. Physical Properties and Chemical Constitution. Part IX. Aliphatic Hydrocarbons.** A. I. Vogel. *J. chem. Soc.*, Feb. 1946, 133.—New experimental data for the parachors and refractivities of the normal hydrocarbons (*n*-pentane to *n*-hexadecane) and certain branched-chain hydrocarbons are presented. The data for the normal paraffins give for $CH_2$, P 39·98, $R_C$ 4·618, $R_D$ 4·643, $R_F$ 4·687, $R_G$ 4·731, and $Mn_D^{20°}$ 20·63. By combining these figures with those deduced in Part VIII (*J. chem. Soc.*, 1943, 638), the following figures for $CH_2$, H, and C (in $CH_2$) have been obtained:

| | P. | $R_C$. | $R_D$. | $R_F$. | $R_G$'. | $Mn_D^{20°}$. |
|---|---|---|---|---|---|---|
| $CH_2$ . . | 40·02 | 4·624 | 4·647 | 4·695 | 4·735 | 20·59 |
| H . . | 15·7 | 1·026 | 1·028 | 1·043 | 1·040 | −2·46 |
| C (in $CH_2$) . | 8·6 | 2·572 | 2·591 | 2·601 | 2·655 | 25·71 |

T. M. B. M.

**610. Stability of D.D.T. and Related Compounds.** E. E. Fleck and H. L. Haller. *J. Amer. chem. Soc.*, 1946, **68**, 142–143.—The action of catalysts such as iron, chromium, anhydrous ferric chloride, and aluminium chlorides in eliminating hydrogen chloride from D.D.T. is discussed. The decomposition is inhibited by certain solvents and other impurities present in the technical grade. Their removal on further purification of the material may lead to an apparent instability of the D.D.T., since contamination with traces of catalytic material may easily result in air-drying and other operations. An explanation is thus offered for the belief that pure D.D.T. is less stable towards heat than is the technical grade. J. H. P.

**611. Bromine Analogs of D.D.T.** S. J. Cristol and H. L. Haller, *J. Amer. chem. Soc.*, 1946, **68**, 140–141.—The preparation of 1-tribromo-2 : 2-bis-(*p*-chlorophenyl)-ethane (I) and 1-tribromo-2 : 2-bis-(p-bromophenyl)-ethane (II) by the sulphuric acid-catalysed condensation of bromal with the appropriate halobenzene is described. Compound (I) is fairly stable, and has m.p. 146–147° C. Compound (II) is very unstable. Both (I) and (II) eliminate hydrogen bromide in alcoholic alkalies to form the corresponding olefines, the oxidation of which to the *pp'*-dihalobenzophenones locates the position of the ring halogen atoms. Dinitro-derivatives of (I) and (II) have also been prepared. J. H. P.

## Analysis and Testing.

**612. Assembly and Calibration of a Density Balance for Liquid Hydrocarbons.** A. F. Forziati, B. J. Mair, and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, Dec. 1945, **35**, 513.—The assembly and calibration are described of a density balance for rapidly measuring the densities of liquid hydrocarbons on samples as small as 9 ml in volume. The reproducibility of the measurements is $\pm 0{\cdot}00002$ to $\pm 0{\cdot}00003$ g/ml, and the overall uncertainty is estimated to be about $\pm 0{\cdot}00005$ g/ml. T. M. B. M.

**613. Kinematic Viscometer for Opaque and Very Viscous Liquids.** E. H. Zeitfuchs. *Oil Gas J.*, 12.1.46, **44** (36), 99.—An instrument has been developed for determining the viscosities of very viscous, opaque liquids, especially useful in the range of 1000–75,000 cs. It consists of an enlarged glass bulb from which extend capillary tubes above and below. Drainage effects, which limit accuracy, have been minimized by the use of a horizontal tubular reservoir; and a siphon makes loading convenient and precise. About 1 ml of sample is introduced through the enlarged bulb, and the apparatus manipulated so that the time of passage of the meniscus of the sample between two marks on the small vertical bulb is noted. The kinematic viscosity is calculated from a given formula. Tests with various petroleum liquids of known viscosities have established that the diameter of the horizontal tube is such that neither "drainage" nor surface tension differences had an appreciable effect on accuracy of results.

Dimensions of the instruments are determined by the range of viscosities to be determined, final adjustments to exact values of constants are made by changing the volume of the lower bulb slightly or by locating graduation lines during calibration. Calibration is made with liquids of known kinematic viscosity, the flow time in any given viscometer being limited to between 100 and 600 sec. G. A. C.

**614. Evaluation and Manufacturing Methods of Ball- and Roller-Bearing Greases.** A. E. Hickel. *Refiner*, Feb. 1946, **25** (2), 61–64.—The Annular Bearing Engineers Committee (ABEC) bearing test is critically discussed, and its deficiencies on long-period use of the bearing are indicated. The different effects of temperature on different greases are outlined. Results of different bearing greases made in a simple testing machine equipped with SKF ball bearings are shown photographically. These bearings were held in a sleeve-type housing, and could be operated at various temperatures, speeds, and pressures. An automatic rheostat controlled the box which enclosed the bearing machine, and each bearing housing was equipped with a thermocouple for reading temperatures on a potentiometer. The bearing and box temperatures were taken every half-hour. The speed was 966 r.p.m., or equivalent to 75 miles/hr and

the load was 100 p.s.i. Photographs show the conditions of the grease and bearings after 10,000, 13,000, and 25,000 mile-runs. Results of tests on greases manufactured by different methods and having different constituents are presented. A. H. N.

**615. Petroleum Research Goes Electronic.** R. Sneddon. *Petrol Engr*, Nov. 1945, **17** (2), 59.—A description of physical methods of test involving electronic applications is given, together with their suitability for analysis and control in the petroleum industry.

The electronic microscope uses an electron beam to illuminate the specimen, which eventually is made visible on a fluorescent screen; magnifications of about fifty times greater than those with the highest power light microscope can be obtained. It is thought that this instrument will be of use in helping to solve problems depending on minute structural differences in such mechanisms as isomerization, polymerization, catalysis, etc.

The mass spectrometer depends on the deflection, by means of a magnetic field, of ionized particles of the molecules of a mixture, according to their mass. By amplification the streams of ions are measured by a series of galvanometers, and the deflection recorded photographically as a spectrum. The mass spectrometer lends itself admirably to the detection of impurities, differentation of isomers, and most gaseous hydrocarbons, and should therefore be of great value to the petroleum industry.

The emission spectroscope depends on the fact that when a substance is burned, the character of the light evolved can be used to determine its composition, and is at present primarily adapted to the identification of metals and alloys. When quantitative results are needed, the optical density of the significant spectrum lines are measured on a densitometer and compared with those of known samples of similar composition. In the control of refining processes this instrument is used for the examination of catalysts for traces of metals.

X-ray diffraction is mainly used for the study of crystalline substances, but has been found of great value in the identification of inorganic deposits on engine parts, as well as determination of molecular weights and the study of lubrication and lubricants.

Infra-red absorption. The sensitivity of this medium is largely due to the fact that in the spectrum of electro-magnetic frequencies the range from 1–30 microns (the infra-red area) corresponds closely to the vibration frequencies of atoms or groups of atoms in the hydrocarbon molecule. This instrument quickly identifies hydrocarbons in the gaseous, liquid, or solid form in mixtures, and is therefore valuable for qualitative and quantitative analysis of hydrocarbons when the number of components is limited to about ten. The study of junctional groups within molecules, as well as the identification of the molecules themselves, is also an important application of the instrument. T. M. B. M.

**616. Neutralization Number Test for Additive Oils is Subject to Misinterpretation.** D. P. Thornton. *Nat. Petrol. News. Tech. Sect.*, 7.11.45, **37** (45), R. 885.—A summary is presented of the five papers representing the views of industrial, turbine, and automotive engineers, received in response to a questionnaire made by the A.S.T.M. Sub-Committee on Neutralization Number and Saponification.

On the industrial side, neutralization numbers are commonly used in checking used non-additive oils for deterioration. Half the replies show that oil is renewed when a maximum limit has been reached, the limits range from 0·20 to 2·0, the majority favouring a narrower range of 0·7–1. The other half of the users are divided between those who use the rate of increase in neutralization number and those who use both a maximum limit and the rate of increase, as indicating the degree of oil deterioration. In the case of additive oils, users do not appear to be well versed in the use and behaviour of this type in service, but apparently they realize that unusual neutralization numbers for additive type oils are not important, provided these oils are superior to non-additive oils for some services.

The viewpoint of the turbine industry shows that neutralization numbers are generally used as a factor in determining when an uninhibited oil should be sweetened or discarded. When inhibited oils are used, the neutralization number is not considered satisfactory, as the changes are only very slight. Interfacial tension tests are definite, and predict breakdown long before there is a change in the neutralization number; where interfacial tension apparatus is not available, the saponification value is a good

substitute, as there is a direct correlation between the two. Other tests also considered more satisfactory than neutralization numbers are described, particularly foaming and sludging tendencies. The best perhaps is the present turbine-oil-stability test, modified to include appearance of the oil and catalyst coils, in addition to the neutralization and saponification numbers. This is described and fully discussed. When rust and oxidation inhibited oils are observed during this test remarkable differences become apparent which are not shown by the neutralization number.

In the automotive industry greater confusion in interpretating neutralization number appears to exist than in the other two groups. Two aspects are apparent, and are discussed: those of the mechanical and those of the service engineers. To the former interested solely in design and manufacture, neutralization number is of no value; its value to the service engineer becomes apparent later. Lack of correlation between neutralization number of the oil in service and the condition of the engine further confuses engineers. This is discussed in relation to the tabulated data of used oil analyses and condition of engine parts. It is shown that the test value of an oil is of interest to service engineers provided that information concerning type and composition of the base oils and addition agents is available. Tabulations: analyses of two different oils operated in the same type of gasoline-engine equipment under the same type of normal road operation and analysis of six oils run in G.M. 71 diesel engine, are discussed from the same aspect. Such data are available in following the changes that take place in service, provided knowledge of the type of oil and additive involved is available.

It would appear that, in general, industry is not very familiar with the service behaviour of additive type oils, and there is a danger that, through misunderstandings, neutralization number specifications may become sufficiently restrictive to constitute a barrier to adequate development of these heavy-duty oils. It has been demonstrated that neutralization number is an inadequate criterion for predicting the useful life of oils containing additives, especially oxidation inhibitors. W. H. C.

## Crude Oils.

**617. The Desalting of Petroleum Oils.** G. Armistead, Jr. *Oil Gas J.*, 23.3.46, **44** (46), 81.—A discussion is presented on the difficulties occasioned in refinery processing by the presence of salt in crude oil, and on the means employed for desalting.

The presence of salt in crude oil causes deposits in two places in refining units: (*a*) where water is being evaporated from the crude, causing salt deposits, and (*b*) where cracking conditions prevail, depositing salt on tube walls, etc., with or without coke. Hydrolysis of salts such as magnesium chloride, releasing hydrochloric acid, occurs at ordinary distillation temperatures, and the acid must be neutralized to prevent corrosion.

Four methods for salt removal are given: (*a*) water flashing; (*b*) water washing and settling; (*c*) water washing and electrical precipitation; and (*d*) propane deasphalting (a modification of the process employed for lubricating oils). Each of these methods is described and diagrams of the plant used are included. A list of references to the literature is appended. T. M. B. M.

## Gas.

**618. Liquified Petroleum Gas Sales in 1945 up to 21·4 per cent over 1944.** G. G. Oberfell and R. W. Thomas. *Oil Gas J.*, 12.1.46, **44** (36), 64.—Sales in 1945 of liquid gas exceeded 1 billion gal, an increase of 21·4% over 1944, domestic usage accounting for over half a billion gal. Distributors have erected new bulk stations, and new equipment has been ordered to meet the expected increased demand. Over a quarter of a billion gal was used as industrial fuel, a 4·8% increase over 1944. Utility companies have increased their gas-producing capacity by installing liquified petroleum gas facilities, this accounting for 60 million gal, an increase of 25·6% over 1944. For the production of chemicals, 220 million gal of $C_3$ and $C_4$ hydrocarbons were used, an increase of 48·8%, and large quantities have gone into motor fuel.

The Liquified Petroleum Gas Assoc has continued active in promoting safety

regulations. It is estimated that the quantity of $C_3$ and $C_4$ hydrocarbons produced represents only 10% of amount available.

Recent developments have been used for flame cultivation (weed destruction) and controlled atmosphere annealing with radiant-tube furnaces. G. A. C.

## Engine Fuels.

**619. Utilization of Non-petroleum Fuels in Automotive Engines.** J. T. Duck and C. S. Bruce. *Bur. Stand. J. Res. Wash.*, Dec. 1945, **35**, 439.—A number of substitute fuels and blends were tested to determine their relative efficiency in the operation of common types of engines. The tests showed that the maximum power developed with alcohol and with some of the other fuels was slightly greater than with gasoline. The specific fuel consumption with the various fuels was approximately in inverse proportion to the heat of combustion of the fuel used. Analysis showed that the mixture distribution was less uniform with the substitute fuels than with gasoline. Tests made with low-proof alcohols showed that an engine can be operated on blends as low as 70 proof, but it is ordinarily impractical to use a blend much below 190 proof because of the excessive volume required. T. M. B. M.

**620. Sulphur Compounds from Panuco Gasoline II.** W. Friedmann and C. Rodriguez. *Refiner*, Feb., 1946, **25** (2), 53–60.—The treatment of a particular gasoline sludge with different reagents to isolate the sulphur compounds from it is given in full, comparing results with those of previous investigators. Thus treatment with mercuric chloride isolated the compounds, all cyclic sulphides, after repeated crystallization, treatment with sodium sulphide or hydrochloric acid and steam distillation, drying, and rectification. The properties of the compounds and the chemistry of the complexes met are detailed.

Sulphur compounds of sulphuric acid and phosphoric acid treatment of sludges are also discussed. The use of perchloric acid is finally studied. The potential value of the sludge as raw material for the organic chemical industry is indicated.

A. H. N.

**621. The Blending Octane Numbers of 2 : 5-Dimethylfuran.** H. B. Nisbet. *J. Inst. Petrol.*, March 1946, **32** (267), 162–166.—Following a review of the theory of knocking combustions and the influence of the chemical nature of the fuel thereon, inductive reasoning suggests that 2 : 5-dimethylfuran should have high-blending octane numbers in admixture with basis fuels of low octane number. The results of engine tests confirm this. A. H. N.

**622. The Story of Di*iso*propyl.** R. C. Alden, F. E. Frey, H. T. Hepp, and L. A. McReynolds. *Oil Gas J.*, 9.2.46, **44** (40), 70.—Di*iso*propyl (2 : 3-dimethylbutane) is a hexane of high octane number with medium-high volatility, boiling point 136·4° F, and Reid vapour pressure of 7·35 lb.

It occurs naturally in crude oil in small amounts, and was first manufactured on a large commercial scale by Phillips Petroleum Co. in August 1944. Ethane and propane are subjected to low-pressure cracking to produce ethylene, and *n*-butane is isomerized to isobutane. The ethylene and isobutane are then reacted together in the presence of an aluminium chloride catalyst to yield diisopropyl. In the absence of catalysts and at high temperatures and pressures neohexane is formed instead.

The chemistry of the process is discussed and equations are given indicating the probable course of the reaction. The effects of reaction variables, feed composition, etc., are dealt with in some detail.

Di*iso*propyl concentrates containing upwards of 93% of the hydrocarbon are readily obtained by fractionation of the alkylates. The pure hexane with 4 ml. T.E.L. has an A.S.T.M. aviation rating of 113·2 octane number, while its weighted blending value (plus 4·0 ml T.E.L.) varies from 117·0 to 112·6, with average value of 114·3.

The supercharged rich-mixture blending rating of di*iso*propyl with 4·0 ml T.E.L. varies from 200·9 to 167·0% of its power obtained with S reference fuel, the average value being 182·7. D. L. S.

**623. Effect of Fuel Properties on Diesel-Engine Performance.** F. G. Shoemaker and H. M. Gadibusch. *Oil Gas J.*, 12.1.46, **44** (36), 74.—Correlation of chemical and physical properties of a gas oil with actual engine performance is not always possible, thus ignition quality is rated by engine-test methods. The transformation of the heat content of the fuel into mechanical power takes place in three distinct phases, as shown by indicator diagrams. A period of ignition delay is followed by one of rapid pressure rise, and finally remainder of injected fuel continues to burn at a slower speed for some time until polytropic expansion begins. Ease of vaporization and ignition influences the delay period. Investigations of the effects of fuel composition are complicated by natural fuels being composed of many molecularly different components, and on account of the intrinsic relation of their physical properties to their chemical composition.

Prevailing cylinder pressure was determined in a multicylinder two-cycle diesel engine, full-load performance details being obtained by conventional methods, using twelve fuels of various compositions. Less time is required to ignite and burn the fuel at high engine speeds, and fuels of different cetane rating show ignition delay in their respective order at the various speeds, with the exception of the 46-cetane fuel, whose curve coincides with that of the 51-cetane fuel at all but the top speed, these two fuels having materially higher aromatic content. In the second phase of combustion only the 22-cetane fuel reaches maximum cylinder pressure earlier than the other four tested. In the final combustion period the higher-cetane fuels burn faster than even the 57-cetane fuel at 2100 and 800 r.p.m.

Four fuels were used to investigate influence of vaporizing characteristics, and among other results it is shown that ignition delay of all fuels of the volatility group is practically alike, and within the range of the corresponding fuels of the cetane group, identical results being obtained in the part load range down to 50% load. Thus for combustion, power, and economy, fuel variations within a wide range of properties have no significant effect on this type of direct injection engine under normal conditions. A figure shows the variation of motoring compression pressure as a function of engine speed, and other diagrams indicate that the speed of compression-ignition engines is not limited by the combustion process. Automotive type of service such as city coach operation demands employment of special fuel. Tests on cold starting show that a fuel of 80-cetane is required to start a compression ignition engine without special preheating, at about 0° F, and it is important to rate ignition quality of fuels also in the low-temperature range. G. A. C.

## Lubricants.

**624. New Synthetic Lubricants.** J. C. Kratzer, D. H. Green, and D. B. Williams. *Refiner*, Feb. 1946, **25** (2), 79–90.—*Paper presented before Society of Automotive Engineers.* The purpose of this paper is to describe in some detail the characteristics of two series of synthetic lubricants having certain unusual properties. Until recently these compounds were subject to an order of secrecy issued by the Commissioner of Patents. Both series of lubricants are currently being produced on a commercial scale by Carbide and Carbon Chemicals Corpn. One series of synthetic lubricants, which is essentially insoluble in water, is designated by the symbol "LB" followed by a number representing the viscosity at 100° F. in S.U. secs. The other series, the members of which are soluble in water at room temperature, is designated by the symbol "50-HB," similarly followed by a number designating the Saybolt viscosity at 100° F. These new synthetic lubricants are a development of American science and industry. They are not related to the synthetic lubricants developed in Germany. Those were primarily developed to substitute for natural petroleum products which were unavailable to the Germans during the war period. They exhibit properties which are superior to these German products, and they differ from them chemically. The new synthetic lubricants described in this paper are synthesized from natural or other hydrocarbon gases as raw materials. They contain no petroleum oils. They are inherently more expensive to produce than the best petroleum lubricants now sold. This factor will probably limit the market for these products except where their special properties justify increased cost. Both the LB series (water-insoluble) and the 50-HB series (water-soluble) of synthetic lubricants are being manufactured and sold by Carbide and Carbon Chemicals Corpn. under the trade-mark "Ucon" for a wide variety of industrial applications. A. H. N.

**625. Viscosity of Lubricating Oils at Low Temperatures (3).** L. G. Zherdeva, Z. Vozzhinskaya, and O. Fedoseeva. *Petroleum*, Apr. 1946, **9** (4), 76.—On cooling a viscous oil to −15° C. the crystallization of paraffin wax with the formation of a crystalline lattice causes anamalous viscosity long before the pour point.

Such structural viscosity depends on all the usual factors, including thermal history. Marked cooling exerts an influence on the viscous properties of the molecules.

Synthetic lubricants have exceptional mobility at low temperatures consequent upon their structure, but the introduction of an aromatic ring into such an oil lowers its mobility.

Inferior mobility of petroleum oils is primarily due to content of free paraffins; and an increase of pressure of 1000 kg/cm$^2$ causes an increase in the viscosity of oils by 4–10 times, the viscosity/temperature coefficient of oils deteriorates with increasing pressure.

The addition of synthetic oils to low-grade petroleum oils improves the fluidity characteristics of the latter. G. A. C.

**626. Charts show Viscosity and Oxidation changes in Used Crankcase Oils.** C. M. Larson. *Nat. Petrol. News. Tech. Sec.*, 7.11.45, **37** (45), R. 891.—By the use of a viscosity comparator instrument, reading Saybolt seconds direct at 100° F., a simple means is afforded for checking viscosity changes of used lubricating oils. Charts are given for ascertaining: (1) the dilution of; and (2) extent of oxidation of lubricating oils used in: (*a*) gasoline; and (*b*) diesel engines. They are based on changes in viscosity of (1) a loss through dilution, caused by blow-by or fuel leakage, and shown as percentage dilution by the gasoline or diesel fuel; and (2) an increase, through oxidation caused by excessive crankcase temperatures over extended periods of usage and expressed as percentage viscosity increase.

The gasoline-engine oil chart is also used for determining whether the engine is operating too cold or too hot—if too cold, dilution results; if too hot, oxidation results. Examples for using the charts are given. W. H. C.

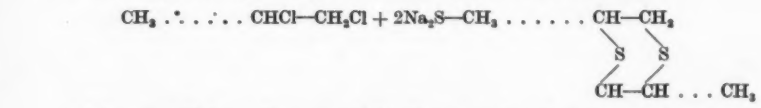
**627. Sulphur and Sulphur Chloride Organic Reaction Products as "Lube" Oil Additives—2.** C. G. Pritzker. *Nat. Petrol. News. Tech. Sect.*, 7.11.45, **37** (45), R. 871.—108 U.S. patents from 1926 to 1945 are surveyed and the patent history is reviewed from 1872. Lard-oil substitutes are discussed. The subject naturally covers the use of many types of sulphur and sulphur compounds, reacted with various kinds of oils. In many patents the method of preparing the improved lubricating oil or additive, and sometimes the reaction equation and/or formula of the product and their uses are given. Some interesting recent specifications are:—

James in U.S.P. 2,209,976/1940 stabilizes mineral oils by adding sulphur chloride and alkylamine reaction products; sulphur is not suitable for stabilizing transformer, turbine, or technical white oils, but Story (2,211,798) states the following are suitable for such oils: alkyl disulphides, arylalkyl disulphides such as diethyl, di-*n*-butyl, di*iso*amyl, dibenzyl, diphenyl ethyl, diphenyl *n*-propyl, benzothialzole, and tetramethyl thiuram disulphides.

The use of silent electric discharge is specified in two patents. Pier (2,258,806, 1941) so treats hard paraffin wax plus 30% ceresin and 0·5% sulphur, afterwards distilling off the unreacted. The product contains 0·3% sulphur; Wiezevich (2,178,769/1939) so treats mineral oil plus 0·1–2% sulphur, to increase the efficiency of the voltolized product as an oxidation inhibitor.

Three patents react iso-olefins in various ways; Morway (2,364,382/1945) reacts high-mol.-weight polymer—*e.g.*, isobutylene—with $SCl$ or $S2Cl_2$ and obtains an E.P. additive; Plummer (2,227,691/1941) reacts isobutylene polymer with sulphur at 375–400° F. for 60–120 minutes so that only 0·05% is added, or if $SCl_2$ is used the initial temperature should be 100–110° F. for 30 minutes, and finally at 300° F. for 1 hour, and obtains a synthetic lubricant which prevents scoring and scuffing in the cylinders and parts; Barnard (2,227,692) adds isobutylene polymers to a naphthenic or coastal cut and adds 0·005–0·5%sulphur, or uses a high-sulphur mineral oil. The additive produced inhibits carbon deposition and prevents ring-sticking; Townes (2,364,830) obtains an i.c. lubricant with E.P. properties by reacting depolymerized rubber polymer with $SCl_2$ so that both S and Cl enter the product. Smith (2,378,803/1945) acidifies an oil before reacting it with sulphur; the product must be neutralized. By this method

lower temperatures are required and the product is not darkened. Smith (2,377,654) by adding potassium oleate to sulphurized sperm oil, inhibits it against foaming. Farrington (2,346,156/7) by a condension reaction obtains a long chain (>20 carbon atoms) multibridge thioalkyl compound; by reacting inorganic sulphides with a long-chain halogenated hydrocarbon, the following reaction takes place.



These so-called paraffin-wax polythiodimers are from four to eight times as effective as cetyl ethyl sulphide, and more than three times as effective as a conventional dialkyl disulphide, when used as lubricant for *i.e.* engines and hard metal bearings, and are non-corrosive in the presence of refined lubricants under severe operating conditions. W. H. C.

**628. Lubrication Vade Mecum Addendum (4).** E. W. Steinitz. *Petroleum*, Apr. 1946, **9** (4), 75.—This further part of the addendum to the Lubrication Vade Mecum includes notes on lubricants for steam hammers, hydraulic presses, accumulators, testing machines, rolling and Mannesmann mills, clocks, optical instruments and mechanical appliances such as speedometers and typewriters. G. A. C.

**629. Secrets of German Lubricating Oil Technology in War-Time. Highlights of C.I.O.S. and B.I.O.S. Reports to Date.** C. I. Kelly. *Petrol. Times*, 2.3.46, **50** (1268), 207. Part I. Lubricating Oils: Production and General Policy.—This is a review of a number of the reports issued by C.I.O.S. on the information gained as to the state of German oil technology at the close of the war.

Owing to the cessation of all oil imports from overseas from the first day of the war, Germany had to depend largely on indigenous crudes. Production of crudes amounted to 1,920,000 tons/year exclusive of Roumanian (alleged 6,000,000 tons/year) and Hungarian sources, whose products were supplied direct to the Services in the Eastern areas.

Statistics show that production of synthetic lubricating oil amounted to rather less than 10% of the total lubricating-oil production. It must be noted, however, that ultimately the Germans depended for aircraft lubricants almost entirely on the products of their synthetic plants. Synthetic lubricating-oil stocks were much more viscous than "conventional" bright stocks, and this allowed the incorporation of a comparatively large volume of low-viscosity neutrals in aircraft oils.

Precision bombing ultimately reduced output of these plants to such an extent that attempts were made to rebuild underground, and at the conclusion of hostilities several of these projects were almost completed.

The necessity for increased lubricating-oil production encouraged the development of recovery processes and the utilization of "waste products."

Thus extracts from Edeleanu refining were used as rubber extenders, constituents of printing inks, putty substitutes, etc., while Duosol extracts were distilled to produce a distillate lubricating oil and an asphalt residue.

Spent fuller's earth was extracted with gasoline to dissolve out the oil which was subsequently recovered, while the earth after extraction was used as a filler and plasticizer for synthetic rubber.

Used aero-engine oils were recovered by removing diluent and solid particles and incorporating to the extent of 10% in the charging stock fed to the Duosol plants. Used oils from the Army and Navy were also recovered, the Army oils mainly by small firms, the Navy oil by the Kriegsmarine. D. L. S.

## Special Hydrocarbon Products.

**630. Crystallography of Waxes and Related Substances.** L. Ivanovszky and J. H. Wredden. *Petroleum*, Apr. 1946, **9** (4), 82.—In this first of a series on waxes and related substances crystals from wax solutions, and their transitions, are discussed.

Commercial paraffin wax, m. pt. 60° C, was dissolved in carbon tetrachloride, alcohol

added, and the heated solution allowed to cool, the precipitation of wax crystals slowly occuring.

After 24 hours this precipitate consisted of large plates about ¼in in length, with crenated edges and no definite angles. The solution contained microcrystals, from which a structure-less film of wax formed, trapping beneath needle-shaped microcrystals of 5–20 $\mu$ length and 2½–5 $\mu$ diameter. The crystals disappeared over night, giving place to minute globules of wax about 1 $\mu$ diameter. After a week the wax solution exhibited an agglomeration of quadrangular plates with needles still in the liquid. Periodic examination of a slide from solution which had been standing eight weeks showed no change until nearly twelve hours had elapsed, when the needle crystals apparently unrolled to form irregularly shaped plates. Microphotographs illustrated this transition, showing needles formed plates of same length, only the breadth increasing. G. A. C.

**631. Mineral Oil and Dowty Liquid Springing.** Anon. *Petrol. Times*, 2.3.46, **50** (1268), 225.—The Dowty liquid spring operates at pressures up to 100,000 lb/sq. in. and utilizes liquid compression.

Light mineral oils have proved the most suitable fluids for this purpose, and a liquid which can be compressed by 20% of its original volume at 60,000 lb/sq. in. has been developed.

The device consists of a pressure-sealed cylinder filled with oil and containing a piston carrying valve mechanism. Secured to the piston-head is a rod which emerges through a high-pressure gland. A grease-filled recess in the gland retaining nut lubricates the piston-rod.

When the rod is forced into the cylinder the oil is compressed and simultaneously transferred from one side of the piston to the other. The valve in the piston-head opens fully during compression, but on recoil it closes so that movement is damped and excellent shock-absorbing qualities obtained.

The liquid spring has been made possible by the development of the high-efficiency gland, which permits smooth action of the piston-rod. D. L. S.

**632. D.D.T. Possibilities for Oil Industry explained by Chemist: Distributors told of Limitations.** H. Ridder. *Nat. Petrol. News*, 13.2.46, **38** (7), 22.—Kerosine, alcohols, ketones, and chlorinated hydrocarbons are among the most suitable solvents for D.D.T., and although kerosine is the most common and efficient it has its disadvantages, the most serious to housewives being its odour. Kerosine deodorized by the conventional methods has been found suitable. For household use solution of D.D.T. in deodorized kerosine is limited to 2%, although normal kerosine will take a 5% blend suitable for farm use and other places where odour is no objection.

D.D.T., properly applied, is effective against body lice, bedbugs, flies, mosquitoes, clothes moths, carpet beetles, and silver fish, but its effectiveness on ants, cockroaches, spiders, ticks, screworm, heel fly, chigger, and poultry mite has not been fully determined.

Its use in oil paints so far is limited; in an oil-base solution it should not be used on animals since it is highly toxic. Powder forms are available. D.D.T. itself is not particularly harmful to human beings, but once mixed with oil it becomes very toxic and if taken internally may prove fatal.

As a spray on crops, it has certain advantages, but also presents many problems. Care must be taken so that in spraying to rid an area of a pest, the D.D.T. will not cause the destruction of numerous beneficial insects, particularly the honey bee. D.D.T. falling on streams can also kill fish.

Finally, D.D.T. should not be used on grain, forage, or other crops that are to be used as animal feed because of the possible danger associated with residues, and care should also be taken to avoid residues on fruits and other plants or plant products to be used as human food. T. M. B. M.

**633. Domestic Fly Sprays. 2. Insecticides.** C. L. Gilbert. *Petroleum*, Apr. 1946, **9** (4), 79.—Synthetic insecticides, methods of test and theoretical aspects of their mode of action are discussed.

Thiocyanates and related products are the most important synthetic substitutes for

pyrethrum in fly-sprays, although the knockdown rate is not as rapid as with pyrethrum. D.D.T. (*para*dichlordiphenyl trichlorethane) has a very slow knockdown action, but the flies seldom recover, so that combinations with pyrethrum will probably be used. Activators and synergists are added to insecticides to enhance their effect, and perfumes are incorporated to mask the odour of kerosine. The Peet-Grady method of grading insecticides is now widely adopted, and consists of counting the number of flies knocked down after spraying under standardized conditions, which latter includes strain and age of flies, and their food.

Other methods of test have been devised, including the chamber method suggested by Kearns and Marsh, which uses less insects than that of the Peet-Grady.

The characteristics of the particles of spray at impact depend on the nature of the spray and type of gun used. Domestic-type sprayers yield a wasteful large particle spray, whilst very small particles of 20 $\mu$ down to 1 $\mu$ are formed by more specialized sprayers, such as the Phantomyst.

The toxic action will be due to penetration of the cuticle by the kerosine solution when first applied, but after a short time the remaining smaller-sized particles, mainly non-volatile, may cause poisoning by absorption into the breathing system. One effect of addition of sesame oil is to increase the size of residues after evaporation of kerosine and improve penetration by diluting the semi-solid pyrethrum residue.

To be effective the toxic agent must be capable of penetrating into the living cell, and then react with some constituent of it, and thus disorganize the enzyme system. Laüger suggested that the toxic agent contains groupings conferring high lipoid solubility and toxicity, such as the unsaturated lactone grouping in pyrethrum. Martin considers that the toxicity of D.D.T. is due to the $CHCl_2$ group, from which HCl can be split off by reaction in the insect cell. The Laüger theory does not explain differences in the activities of the lævo and dextro forms of nicotine, for example. It is thought that the active agent masquerades as a molecule essential for the life of the cell, hence certain insecticides are only effective against certain insects. Similar theories have been put forward to explain the action of drugs, bactericides, etc.

G. A. C.

## Derived Chemical Products.

**634. Carbon-Black Industry Strains to Meet Requirements for Rubber.** F. R. Staley. *Oil Gas J.*, 9.3.46, **44** (44), 86.—90% of the U.S. production of carbon black is used in reinforcements of synthetic rubber. An average annual consumption for all purposes is estimated at 1140 million lb.

Increase in use of natural rubber would require greater quantities of channel process black, while a decrease in synthetic rubber consumption would reduce demand for semi-reinforcing furnace-type black and increase that of higher reinforcing type. Natural, stripped, and refinery gases are used in the plants which since 1916 are centred in the Texas Panhandle. Research has led to new processes and products, channel black plants have been modified to meet the great demand for this type of black, and new furnace-processes blacks developed for synthetic rubber.

Three processes are used for manufacturing carbon black: the channel, the continuous furnace, and the cycle furnace process. In the channel process natural gas is burnt in a limited supply of air through small lava tips, the fan-shaped smoky flames infringe upon moving iron channels on which the carbon black is deposited. The product is automatically scraped off and transported by a screw-conveyor to the storage tank.

The continuous furnace process permits partial combustion of the gas in specially designed furnaces; the carbon-black formed is cooled with water sprays and separated from the gaseous stream by very high voltage precipitators, aided by a battery of cyclone collectors.

In the cycle-furnace process natural gas is thermally decomposed in special furnaces packed with firebricks or refractory-walled flues. The bricks or flues are heated with a mixture of gas and air, followed by gas alone. The natural gas is decomposed into carbon black and hydrogen, cooled with water sprays, and the carbon black separated from the gaseous stream by a bag filter system. The hydrogen produced may be utilized in the synthesis of ammonia, or as fuel.

The yields by the three processes are respectively 1·0–2·1 lb/1000 cu. ft. of natural gas in the channel process, 3–16 lb in the continuous furnace, and 16 lb/1000 cu. ft. in the cyclic process, depending on quality of gas furnace design, grade of black, and other factors. G. A. C.

**635. Synthetic Organic Chemicals.** Anon. *Nat. Petrol. News* (*Tech. Sect.*), 5.12.45, **37** (49), R. 997.—A recent report of the U.S. Tariff Commission states that some 1,564,914,665 lb of " chemical raw materials " (exclusive of toluene) were derived from petroleum in 1943, while in 1944 the figure amounted to 3,000,000,000 lb on a comparable basis.

The total included, in 1000 lb, naphthenic acid 28,462, xylenes 354,639, ethylene 272,188, propane and propylene 214,555, butadiene 488,945, 1 butene and 2 butene mixture 202,380, all other $C_4$ hydrocarbons 569,087, and all other chemical raw materials excluding toluene 841,240.

Toluene (chemical grades) from petroleum totalled 62,570,000 gal during 1944.

Many figures are given for other chemicals derived in large part from petroleum raw materials, and some interesting statistics are included on plastics and synthetic elastomers. Thus acylic resins in which many " petroleum resins " fall amounted to 380,032,000 lb, while nearly 40,000,000 lb Buna N type and 315,000 lb Butyl production are listed. D. L. S.

## Engines and Automotive Equipment.

**636. Design and Performance of General Electric's Type 1–10 Jet-Propulsion Gas Turbine.** D. D. Streid. *Refiner*, Feb. 1946, **25** (2), 94–96.—Dimensional and operational characteristics of this gas turbine are presented in several graphs. The following table gives a summary of the performance at 11,500 r.p.m. with standard inlet conditions of 14·7 lb/sq in, 59° F.

| | |
|---|---|
| Thrust | 4000 lb. |
| Fuel Flow | 4740 lb/hr. |
| Specific fuel consumption | 1·185 lb/hr/lb thrust. |
| Exhaust temperature | 1170° F. |
| Compression ratio | 4·126. |
| Compressor discharge temperature | 413° F. |
| Combustion pressure drop | 3·18 lb/sq. in. |
| Turbine inlet temperature | 1492° F. |
| Air flow | 79 lb/second. |

A. H. N.

**637. British Aircraft Gas Turbine Progress.** H. R. Cox. *Aircraft Engng*, January 1946.—This is a general review, and, with the aid of excellent photographs and diagrams, documents, in chronological order, the design features and performance data of British gas turbine and jet propulsion engines.

(1) *Axial compressors*—typical performance data are :—

| Date. | Type. | No Stages.. | Optimum Pressure Ratio. | Max. Effic. %. |
|---|---|---|---|---|
| 1939 | Anne (RAE) | 8 | 1·6 | 81 |
| 1939 | Alice (Parsons) | 8 | 1·3 | 85 |
| 1940 | Ruth (RAE) (GEC) | 6 | 2·4 | 83 |
| 1940 | B10 | 9 | 1·4 | 87 |
| 1941 | E5 | 8 | 1·4 | 85·5 |
| 1942 | F2 | 9 | 3·0 | 88 |
| 1943 | A.S.X. | 14 | 3·7 | 87 |

(2) *The Gas Turbine Engines.*

| Type. | R.P.M. | Thrust. | Jet Temp. ° C. | Fuel Consumption lb/lb Thrust/hr. |
|---|---|---|---|---|
| W1 | 17,750 | 855 | — | — |
| W2B | 16,750 | 1,755 | 606 | 1·13 |
| W2/700 | 16,750 | 2,485 | 647 | 1·05 |
| F2 | 7,700 | 3,500 | 630 | 1·1 |
| Goblin II | 17,300 | 3,000 | 660 | 1·3 |
| Derwent V | 14,500 | 3,500 | 660 | 1·1 |
| Nene | 12,600 | 5,000 | 665 | 1·04 |
| ASX | 8,000 | 2,500 | 600 | 1·0 |

(3) *Thrust Boosting Experiments.* With ammonia injection (Power Jets).

| Engine. | $\frac{\text{Wt. of } NH_3}{\text{Wt. of air}} \times 100$. | Relative Humidity of Ambient Air. | Temp. Dop of Jet. | Thrust Increase. |
|---|---|---|---|---|
| W1 Mk. III | 6·15% | 85% | 115° C. | 28% |
| W2B | 4·4% | 81% | 72°C. | 22·4% |

Thrust augmentation was extremely sensitive to humidity.

Experiments with methyl chloride injection were not encouraging.

With water injection on a W2/700 engine, a thrust increase of 18% was obtained with a rate of injection of 102 lb/min.

Reheating of W2B/23 engine :—

| Measured Increase in Fuel Consump. | Measured Increase in Static Thrust at Sea Level. | Estimated Thrust Increase at 500 m.p.h. at Sea Level. |
|---|---|---|
| 30% | 5% | 9% |
| 70% | 10·8% | 17% |
| 100% | 16% | 27·5% |

The article is to be concluded. I. G. B.

**638. Combustion in the Gas Turbine.** D. G. Shepherd. *Engineer*, 22.3.46, **181** (4706), 268; 29.3.46, **181** (4707), 300.—The paper seeks to outline the special problems of gas turbine combustion, and to generalize some of the experience gained in recent years. The author deals with the subject under the following general headings: Design of Combustion Chamber, Combustion Requirements, Efficiency of Combustion, Pressure Loss, Reliability, Carbon Deposit, Stability, Ignition, Temperature Distribution, Fuels and Fuel Injection, Testing and Development of Combustion Chambers.

In his concluding remarks under the heading "Future Requirements" the author states that the combustion chamber can be expected to show improvement with respect to reliability, pressure loss, and decrease in size and weight, and engines may have higher compression ratios and turbine temperatures. Much more knowledge is required on combustion chambers before the design can be predicted from known operating conditions, but advances will be more rapid than in the case of reciprocating engines, owing to the greater possibilities of bench testing. C. D. B.

## MISCELLANEOUS.

**639. Secrets of German Fuel Technology Unearthed.—More C.I.O.S and B.I.O.S. Reports Reviewed.** Anon. *Petrol. Times*, 2.3.46, **50** (1268), 230.—This is a brief review of C.I.O.S and B.I.O.S. reports now available :—

*C.I.O.S.*XXVII—55. A report on two short visits to the Linde Co.'s plant near

Munchen dealing particularly with discussions on the commercial manufacture of $O_2$ and $N_2$ and on the low-temperature separation of hydrocarbon gases (19 pages).

*C.I.O.S.*XXX—102. Report on activities of Scholven hydrogenation plant for production of aviation fuel (29 pages).

*C.I.O.S.*XXX—105. General report on operations of Gelsenberg hydrogenation plant (39 pages).

*C.I.O.S.*XXX—104. General report on activities of Botrop-Welheim hydrogenation plant originally built for extracting coal with a solvent (29 pages).

*C.I.O.S.* XXV—6. Detailed report on Fischer-Tropsch activities at the Moers-Meerbeck plant. First air attack on July 19/20, 1944, practically ended the production of synthetic fuels (150 pages).

*B.I.O.S.*—134. An account of the manufacture at I.G. works at Huls near Marl of synthetic rubber (Buna) from acetylene produced by the electric arc-cracking of hydrocarbon-rich gases (13 pages).

*B.I.O.S.*—118. Reports on the research and development work on fuels and lubricants carried out at the Munich Technical High School (71 pages).

*B.I.O.S.*—121. An account of the detailed examination of one of the chain of WIFO stations (Heiligenstadt installation) mainly engaged in blending and packaging petrol and lubricating oil for the German Army (9 pages).

*B.I.O.S.*—120. Report of an inspection of a WIFO installation (Hitzacker depot) handling Luftwaffe fuels and lubricants. An item of interest was a special portable unit for TEL blending (28 pages).

*B.I.O.S.*—119. Detailed report of the activities of the Deutsche Versuchsanstalt für Luftwaffe Institut für Betriebstoff Forschung in regard to fuel and lubricant utilization and performance. This report contains the following sections :—Aviation, diesel, jet propulsion fuels; fuel for flying bombs; combustion research; aero lubricating oils; greases; anti-corrosion oils. (39 pages.)

D. L. S.

**639. Secrets of German Fuel Technology Unearthed.** Anon. *Petrol. Times*, 16.3.46, **50** (1269), 290.—The following C.I.O.S. and B.I.O.S. Reports are reviewed briefly :—

*C.I.O.S.*XXII—9. I.G. Farbenindustrie A.G. Leuna.

*C.I.O.S.*XXX—88–91. Lurgi Gesellschaft fur Warmetechnik (Frankfurt-am-Main).

*C.I.O.S.*XXXI—23. Metallgesellschaft-Lurgi Frankfurt-am-Main.

*C.I.O.S.*XXX—103. I.G. Farbenindustrie A.G. Works, Ludwigshafen and Oppan.

*C.I.O.S.*XXV—28. Diesel Engine Research and Development in Germany.

*C.I.O.S.*XXX—1–85. Edeleanu G.m.b.H., Altenburg.

A. H. N.

**640. Secrets of German Fuel Technology Unearthed.** Anon. *Petrol. Times*, 30.3.46, **50** (1270), 346–349.—The following C.I.O.S. and B.I.O.S. Reports are reviewed briefly :—

*C.I.O.S.*XXVII—68. Fischer–Tropsch Unit, Leipzig Gas Works.

*C.I.O.S.*XXVII—70. Gutehoffnungshut te A.G. Sterkrade.

*C.I.O.S.*XXIX—40. Lubricants Manufactured and Used by Zeiss in Jena.

*C.I.O.S.*XXVIII—62. Glossary of some German Names for Chemical Products.

*C.I.O.S.*XXXI—27. Coal extraction plant of Ruhrol G.m.b.H.

*C.I.O.S.*XXV—4. Wirtschaftliche Forschungem G.m.b.H. Aussenstelle Munchen I (WIFO I) Stockdorf, nr. Munich.

*C.I.O.S.*XXVII—14. I.G. Farbenindustrie, Hoechst/Main.

*C.I.O.S.*XXIV—9. Synthetic Lubricating Oil Plant, Rhein-preussen, Homberg.

*C.I.O.S.*XXVIII—38. H. Koppers G.m.b.H., Essen.

*C.I.O.S.*XXVI—2. Synthetic Emulsifying agents, wetting agents, detergents and soap substitutes, I.G. Farbenindustrie A.G., Hochst/Main.

*C.I.O.S.*XXVII—85 Miscellaneous Chemicals, I.G. Farbenindustrie A.G. Ludwigshafen and Oppau.

*C.I.O.S.*XXV—26. I.G. Farbenindustrie, Mainkur-Hoechst.

*C.I.O.S.*XXIX—54. Ignition by Means of an Injection of " Ignition Oil."

*C.I.O.S.*XXVI—73. Insecticides, insect repellents, rodenticides and fungicides, I.G. Farbenindustrie A.G. Elberfeld and Leverhusen.

*C.I.O.S.*XXV—24. Die Staatliche Materialprufungsanstalt an der Technische Hochschule.

*C.I.O.S.*XXXI—29. Fuel research activities at the A.G. der Kohlenwertsoff-Verbande, Bochum.

*C.I.O.S.*XXV—27. War-time research on synthetic fuels. Kaiser Wilhelm Institut fur Kohlenforschung.

*C.I.O.S.*XXX—70. The preparation of tetrahydrofuran polymer as a synthetic lubricant for metals.

*C.I.O.S.*XXVII—18. The Oxo Plant, Ruhrchemie, Oberhausen-Holden.

*C.I.O.S.*XXII—21. Synthetic rubber plant Chemische Werke-Huls.

*C.I.O.S.*XXII—7. I.G. Farbenindustrie synthetic rubber plant, Ludwigshafen.

*B.I.O.S.* No. 122. Wirtschaftliche Forschungsgesellschaft m.b.H.

*B.I.O.S.* No. 137. Cyclopolyolefines: Paper by Dr. J. W. Reppe, I.G. Garben. Research Chemist.

A. H. N.

## BOOKS RECEIVED.

**C.R.C. Handbook, 1946.** New York: Coordinating Research Council Inc., 1946. Pp. 558.

Published primarily for technologists engaged in fuel, lubricant, and engine research development, the subject matter falls into two classes, (*a*) current test procedures for fuels developed by the Coordinating Fuel Research Committee, and for lubricants developed by the Coordinating Lubricants Research Committee, and (*b*) information bearing on the formulation, use, and subject matter of these procedures.

The fuel projects are further classified under Motor, Aviation, and Automotive Diesel Fuels and the lubricants projects under Engine Oils and General Lubricants (Gear Oils, Greases, and Hydraulic Fluids).

**The Exploration for Oil in Great Britain and Its Economic Consequences.** G. M. Lees. Nottingham: University College, 1946. Pp. 10. 1*s*.

The 1946 Abbott Memorial Lecture of University College, Nottingham, delivered by Dr. G. M. Lees, surveys the results of the geological work carried out during the past fifteen years by the Anglo-Iranian Oil Co. in the United Kingdom in the search for oilfields.

**Proceedings of the Institution of Mechanical Engineers.** Vol. 152, 1945. London: The Institution of Mechanical Engineers, 1946. Pp. 468 + xi.

This volume contains in its pages the 1944 Presidential Address by Dr. Harry R. Ricardo on "Applied Research." There is also some contributed discussion on the paper by N. Tetlow on "A Survey of Modern Centrifugal Pump Practice for Oilfield and Oil Refinery Services" which appeared in Vol. 150 of the Proceedings of the Institution.

# ABSTRACTS.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# Oilfield Exploration and Exploitation.

## Geology.

**641. Petroleum Reservoirs that Consist of Convex Traps.** Anon. *Oil Gas J.*, 2.3.46, **44** (43), 93.—Simple convex trap reservoirs may be due to structural deformation, or to variation in thickness of the porous zone, or to a combination of the two factors. Differential porosity may be due to thickness variation in deposition, to differential cementation or to lateral variation.

Composite convex trap reservoirs extend across several structural units, while complex convex trap reservoirs have productive intervals composed of separate productive units. G. D. H.

**642. Experimental Well on Atlantic Coast.** Anon. *Petrol. Eng.*, April 1946, **17** (7), 144.—No. 1 Hatteras in North Carolina has reached a depth of 6500 ft. Water was encountered in the Tuscaloosa. G. D. H.

**643. December Wildcat Completions Drop but Year Sets New High.** Anon. *Oil Wkly*, 28.1.46, **120** (9), 40.—The U.S. wildcat completions in December averaged 74·8 per week, compared with 93·5 per week in November. 23% of the November completions were successful.

During 1945 there were 473 new oil discoveries. 315 of these were new fields. There were 154 oilfield extensions. 4337 wildcats were completed in 1945. This was a new record, but well below the P.A.W. goal of 5000.

Tables summarize the results of exploratory drilling in December and during the whole of 1945, according to types and to States and districts.

The December discoveries are listed with brief details. G. D. H.

**644. Future Oil Possibilities of New Mexico.** R. L. Bates. *Oil Gas J.*, 2.2.46, **44** (39), 52.—New Mexico produces over 100,000 brl/day mainly from an area in the southeast of the State, with a smaller amount from the northwest. Roughly three-quarters of New Mexico has more or less promising future oil possibilities.

In southeast New Mexico there are about 10,000 ft of sediments, mainly marine, and not metamorphosed. A notable feature is the buried Capitan limestone (Permian) reef, on or near which lie many of the great oil accumulations. Oil occurs in sandstones, bedded limestones and massive reef limestones. The formations are Tertiary, Triassic, Permian, Pennsylvanian and pre-Pennsylvanian. The first two are non-marine and lack oil; the Permian has produced over 400,000,000 brl of oil, and the older beds are being prospected, promising production having been obtained. There are wedge belts of porosity, as on the margin of the Delaware Basin, from southeast Lea County nearly to Carlsbad.

In the area to the west of the above there are several thousand feet of sediments, except possibly in the mesa country and in parts of the Sacramento Range. A combination of factors seems to rule out much of the Permian as regards oil possibilities. The Lower Permian seems to merit some consideration, and there are signs that the older reefs are farther out in the basin. It is possible that reefs occur in pre-Capitan beds. Pennsylvanian, Mississippian, Devonian, Silurian and Ordovician beds are present. They seem to be marine, but little is known about them. Mississippian reefs are known in the Sacramento Mountains.

Some of the few wildcats have had slight oil shows.

The third area in southwest New Mexico has a cover of alluvium, and lava flows over about four-fifths of its surface. The sediments thin to the west. All the Palæozoic, except possibly the Cambrian, is represented. There are Cretaceous beds in the east. Most of the beds are marine. There is much evidence of alteration. Signs of oil and gas are restricted to the eastern part of the area. On the whole it appears that the oil possibilities of this area are slight.

The northwestern part of the State is underlain by part of the San Juan basin. A deep test on the Rattlesnake anticline found 7400 ft of beds ranging from Upper Cretaceous to Cambrian. The basin has freshwater Tertiary, marine and non-marine Cretaceous, continental Jurassic, Triassic and Permian, marine Pennsylvanian,

Mississippian and Devonian. There are abundant evidences of oil and gas, production having been obtained at twelve localities, from Upper Cretaceous sandstones and Palæozoic limestones. The Rattlesnake pool lies within 3 miles of an igneous intrusion; it obtains oil from the Dakota sandstone (76° A.P.I.) and the Hermosa limestone, and helium-bearing gas from the Ouray–Leadville limestone. Productive stratigraphic traps occur in the Upper Cretaceous. There are undoubtedly wedge belts of porosity in the Pennsylvanian and older beds. Forty-five structures have been recognized, and 30 have been drilled, at least to the Dakota. It is believed that oil has been flushed from many structures.

The fifth area is in northeast New Mexico. Pennsylvanian to Recent beds occur. 8000–9000 ft of sediments may be present in some places, the thickness being determined by the form of the pre-Cambrian beds. Marine, lagoonal and continental deposits are known, and there are numerous evidences of oil. There are seeps, and wells have had oil shows. Several unconformities are known, and some are associated with pre-Cambrian highs. A Pennsylvanian limestone appears to have good oil prospects, and the same is true of the granite wash (Upper Pennsylvanian and Lower Permian) and the Dakota sandstone. In areas of this type tests on the crests of highs may fail because the producing beds wedge out on the flanks. G. D. H.

**645. South Dakota Test has Oil and Gas Showings.** Anon. *Oil Wkly*, 28.1.46, **120** (9), 29.—The Hollingsworth 1 wildcat, near Edgemont, South Dakota, has encountered good oil and gas shows in the third Leo sand. The Morrison sand occurred at 530 ft, the Sundance sand at 790 ft, the Converse sand (Pennsylvanian) at 1710–1840 ft, with a small oil show, the First Leo sand, with some oil, at 2195–2223 ft, the Second Leo sand, with oil and gas, at 2295–2330 ft, and the Third Leo sand was topped at 2396 ft. G. D. H.

**646. Discovery of Oil in Nicaragua Denied.** Anon. *Oil Gas J.*, 16.2.46, **44** (41), 86.—In 1945 a deep well was drilled in Nicaragua for stratigraphical information, and seismic work is under way, but it is denied that oil has been found. G. D. H.

**647. Socony-Vacuum's Barinas Wildcat Down 2900 Ft.** Anon. *Oil Gas J.*, 9.2.46, **44** (40), 62.—Floresanto 4 and 5 of the Sinu area of Colombia have been abandoned as dry holes at 1504 and 1330 ft respectively. In Floresanto 6, the aim is to obtain oil from shallow sands. 1 Pedral has reached 8330 ft, and Socony has a wildcat at 8045 ft in the Magdalena Valley.

Guico 20 has been completed as an oil well at 6927 ft, and 1 Tascabana is being completed as a small gas well. A Barinas wildcat is drilling at 9536 ft, while Socony's Barinas test is at 2900 ft. G. D. H.

## Geophysics and Geochemical Prospecting.

**648. Emanometric Oil and Gas Prospecting.** S. J. Pirson. *Petrol. Eng.*, Jan. 1946, **17** (4), 132.—The emanometric prospecting technique endeavours to measure the absolute emanation per unit area of the earth's crust for one or more gases of diagnostic value, in order to detect commercial oil or gas accumulations. Various pieces of evidence point to the existence of micro-seepages, but objections have been raised. It is possible that oil generation is still going on.

Since methane is formed from decaying vegetation it cannot be used as a reliable indicator of the occurrence of subterranean oil and gas accumulations. Ethane is believed to be a satisfactory indicator. Higher hydrocarbons could also be employed, but their rates of diffusion are lower. The observed rates of emanation of ethane are of the same order as those predicted on the assumption that the formations show an overall permeability of $10^{-7}$ darcy.

In the field the emanations are collected by adsorber tubes, which are then taken to a laboratory for degassing, and fractionation and identification of the diagnostic gases.

It appears that there is a uniform hydrocarbon diffusion field due to present-day generation of oil and gas, possibly directly in life processes, bacterially, by radioactivity or electrolytic synthesis. There is also a possibility of artificial high leakage areas which might be taken for indications of an oil or gas pool. Such artificial highs

may be due to topography and ground-water movement. The measurements must be corrected for these two factors in order to give the anomaly map, which is due to confined pressure sources of oil and gas accumulations. Further corrections are required for soil types, and deep geological effects resulting from structure with a consequent possibility of lateral shift of the anomaly relative to the accumulation.

G. D. H.

**649. Present Status of Electrical Prospecting.** V. G. Gabriel. *Petrol. Eng.*, Jan. 1946, **17** (4), 66.—Electrical prospecting methods use (*a*) natural currents, or (*b*) artificial currents. The latter are subdivided into (1) conductive methods; (2) direct-current measurements; (3) alternating-current measurements; (4) inductive methods; (5) transient methods. Resistivity, transient and radio-frequency methods have been employed in searching for oil.

Resistivity methods have been successfully applied in structural studies of shallow and medium deep horizons, with claims of effective depths of 5000–6000 ft. Some are stated to detect oil directly under favourable conditions. Radio-frequency methods have been applied in structural studies, but are still in the experimental stage.

Tables give examples of the application of the different methods (taken from published descriptions). G. D. H.

**650. Geophysical Prospecting for Oil in India.** A. O. Rankine and P. Evans. *Petrol. Times*, 27.4.46, **50** (1272), 432.—A brief summary of the vast work initiated by the Burma Oil Co. to survey India and Burma by the gravitational method, in order to explore for oil under the alluvial deposits which prevented geological exploration, is given, together with the effect of the war in stopping these surveys and a brief glimpse into the future. A. H. N.

## Drilling.

**651. Porosity of Drill Cuttings Tested by New Method.** M. A. Westbrook and J. F. Redmond. *Oil Gas J.*, 6.4.46, **44** (48), 127.—The well samples containing the cuttings representative of the particular intervals are first washed through a No. 6 gauge screen. The cuttings remaining on the screen are large enough to use for the porosity measurements. From the sized sample, the cuttings to be examined are separated from the shale and other extraneous particles. It is recommended that 10 to 15 c.c. of the selected cuttings be used for measurements, although only 4 to 5 c.c. were used to make the comparative tests described later in the article. These cuttings are extracted and dried by the same methods used for preparing core samples for porosity and other measurements. The clean dry cuttings are weighed, placed in a weighed and volumetrically calibrated graduate, evacuated for approximately 20 min, and then saturated by allowing water to flow into the evacuated system. The system is next opened to the atmosphere and allowed to stand for 5 to 10 min, so that the water will completely penetrate the pores. Longer times may be required for cuttings having very low permeabilities. Water is added until the graduate is filled to the calibration mark. The graduate and contents are reweighed so that the weight of water added may be determined. This weight is converted to volume by knowing the density of the water at the temperature existing at the time the flask was filled to the calibration mark. The resultant volume subtracted from the flask's calibrated volume equals the volume occupied by the dry grains. This volume is later referred to as grain volume. The saturate cuttings are then spread on an alundum disc, which is saturated and in contact with a column of water, being sealed to a funnel, the funnel in hydraulic contact with a reservoir which can be raised or lowered. By lowering the reservoir to a judicious distance, vacuum is created which is just sufficient to drain the excess water without drawing off the water from the pores. The volume of the saturated cuttings is then found by displacement of water from a calibrated cylinder, and thus the bulk volume. Addition of 1 gr of ammonium oleate/l of water prevents air bubbles adhering.

$$\text{Porosity } \% = \left(1 - \frac{\text{grain volume}}{\text{bulk volume}}\right) \times 100.$$

A. H. N.

**652. World's Deepest Cable-Tool Test is Completed.** J. T. Galey. *Oil Gas J.*, 30.3.46, **44** (47), 266.—The deepest cable-tool hole in the world, so far as can be ascertained, has recently been completed by Manufacturers Light & Heat Co., on the Jesse G. Hockenberry farm, Mercer Township, Butler County, Pennsylvania. This wildcat was abandoned, after it showed considerable salt water, at 10,096 ft in what is considered to be an Upper Cambrian sand. Stratigraphically, the test is the deepest yet drilled in Western Pennsylvania, Eastern Ohio or West Virginia. The geology and drilling of the well are described. The rig, tools and lines are described and some of the drilling difficulties are given, such as gas pockets which were encountered with various degrees of explosiveness. A. H. N.

**653. World's Largest Derrick "Walked" Across West Texas Sand Dunes.** E. H. Short, Jr. *Oil Gas J.*, 9.3.46, **44** (44), 60–62.—The derrick and its equipment weigh approximately 125 tons. With the derrick free from all connections, it was jacked up and wooden shoes placed under each corner of the substructure. These shoes, approximately 2½-ft in width and 5 ft in length, were bolted to the upper half of the grillage. Movement of the derrick was then begun (by means of a winch on a 3½-ton truck) on rollers over a plank road. This plank road was carried forward as the derrick was moved. From the time the derrick was jacked up at 7 Sealy Smith to the time it was jacked down at 10 Sealy Smith required only 2 days. It is estimated that the skidding of this derrick saved approximately 14 days over the method of tearing down the derrick and rebuilding it at the new location. A. H. N.

**654. Big Rig Features Unitization and Easy Operation.** G. M. Wilson. *Oil Wkly*, 18.3.46, **121** (3), 32–36.—The rig described is one of the largest gas-powered units in California and is designed to drill to 15,000 ft. Outstanding features include maximum unitization for easy hauling on highways; convenient stair-step design which makes it adaptable to any height or type of sub-structure; direct air-operated friction clutches for both draw works and rotary drives; and unusually convenient, compactly arranged driller's controls. It is driven by three butane-powered engines compounded into a single transmission, an extra shaft being supplied at the rear of the case for driving one of the two mud pumps. Two unitized engines driving to a common V-belt pump sheave power and other pump. Matching the draw works and pump assemblies in portability and accessibility are the efficient and internally strengthened mud tanks, designed for this rig. They may be quickly and easily broken down for transporting, with hinged walkways folding inward to lay on top the open tanks. Among the operating advantages of this tank system are a simplified type of pump suction cut-off which greatly facilitates the job of closing off and opening up suction lines. The entire rig was designed primarily for internal-combustion engines and consists of the draw works, a selective 3-speed forward and reverse transmission, a three-engine compounding transmission, two slush pumps and the structural steel mounting members. At 900 r.p.m., the three butane-powered engines deliver 1000 hp, although this power rig has a nominal rating of 1250 hp. The present installation is about 80% powered, it being possible to add still another engine to the unit if necessary. It has six hoisting speeds—the three rotary speeds, two reverse speeds to the drum shaft and one for the rotary table. While the draw works in itself has but two hoisting speeds, the additional flexibility is gained through the three-speed transmission. Illustrative of the abundance of power available is the fact that on the previous well drilled, some 9510 ft of $\frac{5}{16}$–$\frac{9}{16}$-inch drill pipe was carried easily with only the four upper speeds of its available six being utilized. The present well is the second job for this unit in California. Details of the rig and its performance are given and illustrated. A. H. N.

**655. Byron Jackson New Automatic Drill Pipe and Casing Slips.** Anon. *Petrol. Times*, 27.4.46, **50** (1272), 40.—A new design of drill pipe and casing slips, mounted on an arm which is automatically lifted by air, steam or hydraulic power, is described. A. H. N.

## Production.

**656. The Optimum Rate of Production for Uniform Producing and Variable Depletion Rates. Part 24.** P. J. Jones. *Oil Gas J.*, 9.2.46, **44** (40), 88.—Declining rates of production may be accompanied by uniform or variable rates of depletion. A pro-

cedure for estimating the optimum rate of production for a reserve, a fraction of which is recoverable before production starts declining and a fraction at uniform rates of depletion, was considered in Part 23 of this series. In the present article, variable rates of depletion are considered. A procedure for estimating optimum rates of production for increasing rates of depletion is illustrated by an example on a natural-gas reservoir having water encroachment and one on a cycling project. A procedure for estimating optimum rates of production for decreasing rates of depletion is illustrated by examples on oil reservoirs having marginal reserves. A. H. N.

**657. Oklahoma's First Triple-Zone Completion.** N. Williams. *Oil Gas J.*, 6.4.46, **44** (48), 104–106.—So far, only a relatively few wells, most of them in South Texas, have been completed as triple-zone completions. The complications arising in segregating three horizons in the same well bore have been such until recently as to prevent more general completions of this kind. The triple completion described in this article not only in the first for Oklahoma, but reflects the developments in equipment and technique adaptable for this work. Methods employed ensured the completion of the well with ease and safety. Dimensional details (too many to quote) of the tubings and casings used are given. After setting tubings, packers, etc., each zone was cleaned. With all zones separated, deadweight pressure gauges were taken on each zone for 10 days to make certain all packers were holding. After the ten days, there was 1527 psi pressure on the Glover zone, 1309 psi pressure on the Charlson zone and 1950 psi pressure on the Mona zone, with no apparent leakage. The Charlson (middle zone) was then opened to the atmosphere and the pressure of the other two zones was carefully checked for any drop. Pressure remained constant, proving no leakage existed. The hook up is illustrated diagrammatically. A. H. N.

**658. Selective Control Featured in Recent Choke Installations.** E. H. Short, Jr. *Oil Gas J.*, 6.4.46, **44** (48), 102.—The usual chokes used in well controls vary in size increments of $\frac{1}{64}$ inch. The variation in production rates resulting from a $\frac{1}{64}$-inch increase in choke size may be extremely great. For example, consider that a well flows 135-brl through a $\frac{4}{64}$-inch choke. The well's allowed production may be only 95 brl/day. However, if the next size smaller fractional choke ($\frac{3}{64}$-inch) is used, the production, based upon decrease in choke area, would amount to only 67 brl/day. Thus, the well would probably be produced for a time on the lower rate and for the rest of the month on the higher rate. The sudden increase in the rate may harm the well. Therefore, a series of chokes were designed to give increments of 10%. A chart gives full detail of the characteristics of these chokes. A. H. N.

**659. Automatic Expulsion of Water from Wells Aids Flow.** G. B. Nicholson. *Oil Wkly*, 1.4.46, **121** (5), 33.—To postpone arrival of the inevitable artificial life stage with the corresponding increased lifting costs incurred, several operators in fields on the Gulf Coast instal automatic purgers as part of the surface equipment to intermittently expel the head of water which builds up in the tubing of many wells. The mechanical devices, designed to open automatically for releasing accumulated water when it begins to affect the flow characteristics of a well, are growing increasingly popular, replacing manual manipulation of valves or frequent readjustments is choke size, which requires considerable attention.

A universal operating practice includes the use of a surface choke which applies a back pressure to the formation and the tubing, and retards the velocity of fluids moving through the tubing towards the surface. Often, after water appears in the production, the velocity of fluids is so slow that water separates from the oil and has opportunity to drop back into the tubing with the oil and only minor portions of the water being produced. Accumulation of water which forms in this manner is reflected by a drop in tubing pressure apparent to the surface, and continuance of producing under the same conditions often aggravates the grievance, with the result that increasing amounts of water accumulate in the bottom of the tubing, with pressure dropping accordingly. In many wells, the tubing pressure declines to a negligible factor, and often a well ceases to flow entirely. If, when water first begins to settle, the rate of flow is increased until the water is emptied, many wells will continue to flow longer. To eliminate the obvious operational disadvantages of having personnel present to adjust valves on the Christmas trees as a means of expelling the accumulation of water,

a well purger containing a spring-loaded valve is attached to the flow line and, motivated by variations in the tubing pressure, automatically controls movement of fluid from the well as prevention of forming a water column. The valve is placed in the off-tubing wing of the Christmas tree, or in a bypass around the choke. After the tubing pressure drops to a predetermined value, the spring forces the valve to open, allowing a rapid evacuation of fluid from the tubing, during which period the well produces through both the bypass valve and the regular choke. With emptying of water from the tubing, the pressure rises to normal as volume of gas begins to increase, and the pressure serves as the force to close the valve against the spring pressure.

A. H. N.

**660. New Type Plug-Back Material Tried in Oil Wells.** J. C. Padgett. *Oil Wkly*, 1.4.46, **121** (5), 30–31.—A new type of waterproof plastic cement is being applied on remedial work in producing oil wells, and results have proved gratifying, although full significance of application may not be known until after a number of treatments have "aged" for a year or two. Known as oil-well hydromite, the new compound is composed of a pulverized cementitious filler and a powdered resin. Both materials are activated by the addition of an accelerator and made into a slurry by mixing with water. The setting time of the slurry of plastic cement can be controlled to very close limits. Field tests have proved that an initial setting time within the range of 60 to 100 min is most practical to use in a well and most economical to the well owner in lieu of rig time and other variable costs. The new plastic cement possesses an added feature not usually found in ordinary plastics. It has a linear expansion of approximately 0·3% at the time it takes its initial set. This property has proved very valuable in remedial work where a good tight bond, to either the walls of the casing or the exposed surfaces of a formation, is necessary to ensure adequate protection to the well being worked over. In a manner similar to Portland cement, the material continues to strengthen as it ages for a few hours. Results of an experimental plugging job are given in some detail. A. H. N.

**661. Curves Summarize Investment and Operating Costs for Water-Injection Plants.** L. T. Gibbs. *Oil Gas J.*, 2.3.46, **44** (43), 74.—A graph presents curves which can be used to evaluate the cost in cents/brl from rate of flow in brl/day and the hp of triplex or quintuplex pumps. The basis and use of the curves are explained. A. H. N.

**662. Repressuring Operations in West Texas Pool.** E. H. Short, Jr. *Oil Gas J.*, 9.2.46, **44** (40), 85.—The development and characteristics of the pool are given, followed by a brief study of the repressuring operations undertaken by the operators.

A. H. N.

**663. Well-Interference Studies Are Important in Spacing, Drainage Problems.** K. B. Barnes. *Oil Gas J.*, 13.4.46, **44** (49), 92–94.—For many years the accepted standard spacing was one well to 10 acres. For about the past 10 years a great many pools have been developed on 40-acre spacing—and virtually altogether so during the war period 1942–45. The present majority practice of 40-acre spacing, however, currently is under review in many areas, and for several reasons. One is that war restrictions are now off and those that wish to drill closer may do so. In the other direction, deeper pools are being found, with physical and economic conditions such that some operators desire to space wells further apart than 1 to 40. The question is discussed in this paper from the viewpoint of interference. Reference is made to Muskat's work, which showed that, due to interference, increasing the number of wells in a field does not increase proportionately the rate of production. The ideal conditions of uniform thickness, permeability, circular reservoir with constant influx, complete well penetration and single-phase flow apply. The productive capacity of the first well (6-inch bore) drilled in this ideal field is 1000 brl/day. If a second well is drilled 400 ft away, the combined productivity capacity is not 2000 brl/day, as perhaps might be surmised on first glance, but only 1509 brl/day—due to interference. For three wells so spaced, the total capacity is 1818 brl/day. It is 2061 for a total of four wells, 2132 for five wells, and but 2778 for nine wells. For 16 wells the total productive capacity is not 16,000 brl/day, but only 3333. It is suggested that interference effects can be obtained by shutting in a field or large producing area and, after equilibrium is established or closely

approached, producing one well. The effect on the bottom-hole pressure or fluid levels of the other wells is observed. Or the reverse procedure can be followed, with all wells being produced except the one where the combined interference effects are to be noted. That well, of course, is shut in and pressure or fluid-level tests are made on it. A. H. N.

**664. How to Inject Gas Into Limestone-Dolomite Reservoirs.** J. A. Barnett and M. H. Soyster. *Oil Gas J.*, 23.2.46, **44** (42), 161.—The subject is discussed not in general but with reference to the practices employed in the Grayburg unit area in New Mexico. The development, drilling and production methods and the production data of the field are presented. Oil analysis and oil to gas ratios are presented, followed by the principles used in selecting input wells and injection practice. A. H. N.

**665. Application of Laboratory Data on Phase Behaviour to Condensate-Reserves Evaluation.** E. W. McAllister. *Oil Gas J.*, 9.2.46, **44** (40), 92.—*Paper presented before California Natural Gasoline Association.*—Typical experimental results on retrograde condensation of natural gas under high pressures are reproduced. The significance of these curves in the calculations of reserves, assuming different modes of production, is discussed, showing when production by cycling is to be preferred to production by pressure depletion. A. H. N.

**666. Completions in Rangely Field are Complicated by Tight Formations.** N. Williams. *Oil Gas J.*, 9.2.46, **44** (40), 77.—The field discussed is in northern Colorado. Naturally slow to give up oil, the formation necessitates unusual care in completion of wells to protect the sand face from outside contamination and that means be taken to induce greater porosity if maximum productivity is to be attained. Technically, the separation of well completion begins with the actual drilling of the formation, since the methods employed in penetrating the section have a direct bearing on how clean the sand is kept. In view of its "tightness," the sand is particularly susceptible to being sealed off with drilling mud or "logged" with water infiltration from the mud. A factor in this is the hardness of the formation which substantially retards drilling and lengthens the time the sand face is exposed to the drilling fluid. The production casing string is set and cemented before drilling the producing formation. Details are given. A. H. N.

**667. Drilling and Production Patents.** Pierre Jean-Marie Theodore Allard. Vested in the Alien Property Custodian. U.S.P. 2,390,047, 4.12.1945. Appl. 24.4.1941. Grab used for boring wells.

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Melvin E. Chun, assr to Lane-Wells Co. U.S.P. 2,393,009, 15.1.1946. Appl. 3.11.1942. Electrical well logging method and apparatus.

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## Oilfield Development.

**668. Post-War Oil Supply Areas.** J. T. Duce. *Petrol. Times*, 13.4.46, **50** (1271), 382. —Proved reserves and potentialities of the world in general and of the following countries are given :—Alaska, Canada, Mexico, Central America, Colombia, Venezuela, Ecuador, Peru, Bolivia, Chile, Uruguay, Paraguay and the Guianas, Brazil, Argentine, West Indies, Australia and New Zealand, Africa, Egypt, Roumania, Hungary, Germany and Austria, France, Spain and Portugal, Denmark, Poland, Albania, Italy, England and Ireland, Baltic Republics, Sweden, Norway, Finland, Yugoslavia, Bulgaria, Greece and Switzerland, Belgium and Holland, Russia, China, Japan, Phillipines, East Indies, India and Burma, Afghanistan and Persian Gulf Area. Most of these are treated very briefly. A. H. N.

**669. Proven Reserves Estimated at 20,826,813,000 brl by A.P.I.** Anon. *Oil Gas J.*, 2.3.46, **44** (43), 43.—At the beginning of 1946 the proven U.S. crude oil reserves were estimated to be 20,826,813,000 brl, a rise of 373,582,000 brl during the year. The 1945 production of 1,736,717,000 brl was a record. New pools accounted for 419,984,000 brl of the reserves discovered in 1945. 111,250,000 brl of natural gasoline was produced in 1945, and 4,820,000,000,000 cu ft of natural gas, making the total barrel equivalent of petroleum products in 1945 2,650,000,000 brl. G. D. H.

**670. Oil Rush on in Northwest Colorado.** Anon. *Petrol. Eng.*, Jan. 1946, **17** (4), 224. —Developments are taking place around Rangely, in the Brook plateau region of northwest Colorado. The productive Weber sand, 6000 ft deep, was first penetrated in 1933, but isolation precluded further development until 1945. Reserves are estimated at 418 million brl, with the field limits not yet defined. A 150-mile 10-inch pipeline has been built to Wansutter, Wyoming, where there are trunk-line connections. G. D. H.

**671. Second Test is Planned in Chile's New Oil Field.** Anon. *Oil Wkly*, 18.2.46, **120** (12), 44.—The discovery well of the oil field in the District of Majellanes flowed 200 brl/day through a ¼-inch choke, from 7419–7438 ft. A second well is to be drilled ½ mile to the north. G. D. H.

**672. Alberta Production Decline Continues in 1945.** J. L. Irwin. *Petrol. Times*, 30.3.46, **50** (1270), 328.—Statistical study of Alberta oilfields is presented which shows a general decline in total production, in the daily average and the overall value of the crude. Outside Turner Valley, however, the overall change is towards an increase in production. Turner Valley is nevertheless the most important source of petroleum for Canada, as it supplied 92·13% of Alberta's total production, which production forms 94·01% of Canada's total for 1945. A. H. N.

**673. Kuwait Oil Shipments to Start Within 90 Days.** Anon. *Oil Gas J.*, 16.2.46, **44** (41), 86.—Crude oil shipments from the Burgan field are expected to start in May. The productive capacity is 30,000 brl/day. All the wells were plugged in 1942, and the nine wells are being re-completed. It is hoped to bring in all wells as dual-zone producers, and they are expected to give 2500 brl/day from each zone. The wells are drilled to the Upper Cretaceous, the maximum depth being 4750 ft. The oil is of 32–36·4° A.P.I. gravity, and has 1·9% of free sulphur. The reserves are conservatively estimated at 5,000,000,000 brl. G. D. H.

**674. Crude Runs Start from Second Arabian Field.** Anon. *Oil Gas J.*, 16.2.46, **44** (41), 86.—A 40-mile 12-inch pipeline from Abqaiq to Dhahran has begun to deliver oil, and a 40-mile 12-inch line from Dhahran to Ras Tanura, parallel with the existing line, is under construction.

The Dammam field of the Dhahran area was hitherto Saudi Arabia's only producing field, giving 95,000 brl/day.

Abqaiq is 40 miles southwest of Dhahran. The discovery well was completed in 1941 at 6180 ft, giving oil from the D member of the Arab zone. Five wells have been completed, proving an area about 7 miles long and 3 miles wide, without delimiting the structure in any direction. The structure may be one of the largest in the Middle East. G. D. H.

**675. Zistersdorf Production Receives Sharp Cutback.** Anon. *Oil Wkly*, 18.2.46, **120** (12), 44.—The present production at Zistersdorf is at the rate of 3,226,600 brl/year, but in 1944 it is reported to have produced 9,758,536 brl. G. D. H.

**676. War's End Brings Accelerated Activity in Yumen, China's Only Oilfield.** K. C. Lu. *Oil Gas J.*, 29.12.45, **44** (34), 253.—The Yumen field of Kansu Province was opened in 1939. It is on the northern flank of the Chihlienshan Range. The initial well was completed as a pumper at 500 ft. A flowing well was completed in 1941 at 1430 ft. Development was slow because of supply difficulties, but since the war ended expansion of the production and refining capacity has been begun.

Production is from two Cretaceous sands, both medium grained and of high porosity, and about 150 ft thick. Active seeps occur where the Shihyouho River cuts across the structure, and at an outcrop 2 miles to the east. Little is known about the subsurface structure which seems symmetrical.

Seven wells were drilled between 1939 and 1941, the average depths of these pumpers being 550 ft. Since then 18 flowing wells have been drilled by rotary. Several oil sands have been found beneath the lower producing sand.

Drilling and production practices are briefly described. Output is 1500–2200 brl/day. Several topping batteries and a pipe-still have been built, and a thermal cracking plant is being erected. The crude gives about 21% of straight-run high-octane gasoline. G. D. H.

**677. Chinese Reserves Still a Mystery.** Anon. *Petrol. Eng.*, Nov. 1946, **17** (2), 184.—Oil has been discovered and some reserves proved in Kansu, Shensi, Sinkiang and Szechuan Provinces. There are less substantial oilfields in Chekiang, Kweichow and Sikang. Oil shale occurs in Kwangtung, Shensi, Szechuan, Kwangsi, Chahar, Jehol and Liaoning.

In 1934 there was estimated to be 1376 million brl of oil reserves in Shensi and Szechuan, 2110 million brl in the four northern provinces and 852 million brl of shale oil reserves in Shensi. U.S. Geological Survey estimates were 1375 million brl of crude and 1899 million brl of shale oil. G. D. H.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**678. Selection and Application of Refinery Instruments. Part I.** A. Kreig. *Petrol. Engr*, Jan. 1946, **17** (4), 120.—The major factors which must be considered in the selection of a pressure instrument for a specific application are :—safety, accuracy, flexibility, simplicity, service facilities and standardization. These also apply to instruments for temperature, liquid level or flow. Pneumatic control action is most commonly used, and is classified in three groups :—(*a*) On-off or fixed sensitivity; (*b*) proportional or adjustable sensitivity; (*c*) proportional re-set or adjustable sensitivity with automatic re-set. The application of instruments and accessories for indicating, recording, regulating or control of pressure are shown in diagrams, described and discussed under the following sections :—self-acting regulator, pilot-operated pressure regulator, sump level control, hydraulic coupling scoop control, tower and receiver pressure control. Pneumatic transmission as practised at the Paulsboro refinery is discussed. W. H. C.

**679. Metals and Alloys in the Petroleum Industry.** J. H. Wilson. *J. Inst. Petrol.*, April 1946, **32** (268), 230–240.—The metallurgy of ferrous and non-ferrous alloys and their use, especially in the petroleum industry, is briefly studied. " Safety " tools used for non-sparking applications are discussed, with special warnings against using cast " safety " tools and against using them when they pick up silica dust against steel, as they may spark. A. H. N.

**680. Corrosion Protection of Steel Pipe by Resin Baking Coating.** Anon. *Nat. Petrol. News, Tech. Sect.*, 5.12.45, **57** (49), R992.—A paper on resin baked coatings by induction heating by R. J. Moore, read before the Federation of Paint and Varnish Production Clubs, is reviewed. The phenol–aldehyde resins possess ideal properties for the protective coating of metals and other materials, and during the war their application has been enormously extended. Their many uses are described. The baked resin finishes are plastic coatings which result from the polymerization of the phenol–aldehyde reaction resins on heating (thermosetting), which transforms the alcohol soluble phenol–aldehyde resin product into an alcohol insoluble and infusible material, the so-called C-stage of the process. Because of the polymerization conversion these baked coatings harden to a glass-like surface which withstands shock and high temperatures and pressures without deterioration, and are very resistant to corrosive materials. These thermosetting resins are discussed in comparison with the oxidation films from paints and varnishes and the improvements they afford when used in association with them. Great improvement in the film properties has resulted from the use of induction heating, by which heat is induced in the metal object by passing the coated metal through an electromagnetic field actuated by high or low frequency alternating current. By this means continuous production cycles for transforming the resin coating may be obtained, giving uniform cures in a few minutes, as compared with conventional and infra-red ovens, which take 20–60 min. Another advantage is that, by this method of heating, the film next to the metal is first heated, and the possibility of " case-hardening " does not occur. A diagram of a laboratory continuous induction pipe coating apparatus is shown. The applications of the baked resin coatings in the petroleum industry are discussed.

Coated pipelines buried in various types of corrosive soils remained practically unaffected after 4–6 years.

Low pressure boiler tubes with baked phenolic resin coatings have remained in use for four years without a failure under the same conditions in which uncoated tubes failed in three months, *i.e.*, on the outside water containing mineral salts at 220° F and flame and flue gases through the inside at 675° F.

Admiralty metal tubes in heat exchangers with gasoline or oil outside at 215° F and brackish to salt water at 180–212° F inside, failed in 4 months. Steel tubes coated with baked phenol resin, have been in use two years under the same conditions.

Baked resin coated equipment, in which mixed benzene, steam alcohol and acetic acid is used, is in excellent condition after four months' operation.

Large refinery tests have shown that such coatings withstand the corrosion and pressure conditions in natural gas lines at 720 psi. These tests also involved resistance to lubricating oil and to 30% $CaCl_2$ solution. Similar protective treatment for boiler and condenser is increasing. W. H. C.

**681. New Design of Downspout for Bubble Trays Separates Liquid from Foam and Vapours.** Anon. *Nat. Petrol. News, Tech. Sect.*, 5.12.45, **37** (49), R.990.—A radically new design of down-spout for bubble-cap trays in fractionating columns is described in the U.S.P. 2,385,355, granted on 24.9.45 to C. G. Gerhold and the U.O.P. Co.

The new downspout design consists of two conduits of the same length but differing diameters, one concentric to the other, the outer dips beneath the liquid in the lower tray and extends about one quarter of its length above the higher bubble-cap tray and ends in a cap through which the inner pipe extends about one quarter of its length. The cap top is provided with a number of concentrically disposed ports. On the periphery of the outer pipe (downtake) at a point immediately above the bubble-cap tray is also a series of concentrically arranged ports whose area is insufficient to allow the passing of liquid from the tray beyond the level required by the bubble caps. The functions of the design are described in detail and diagrammatic sketches are shown of it and a slightly different arrangement of the cap head ports.

By such means it is claimed that " a portion of the liquid is utilized as an effective head to induce the flow of liquid from the tray into the downspout whenever the height of the liquid level upon the tray rises above a certain predetermined point. When the liquid upon the tray is below this predetermined point only the height of liquid above the tray is effective as head for inducing flow to the downspout. The increased head effected by the arrangement makes possible the use of smaller downspouts, thereby releasing more tray area for bubble caps." Accumulation of sediment on the trays is also eliminated. W. H. C.

**682. North American Operating Refineries. Their Capacities and Locations.** Anon. *Oil Gas J.*, 30.3.46, **44** (47), 254.—A summary is given of the location and capacities of active plants in the United States and Canada as at 1946.

The type of refinery whether for lubricating oils, asphalt, or gasoline, for example, is stated, together with the crude oil and cracking capacity. The list includes U.S. Government owned synthetic rubber plants, also refineries in Mexico are noted. Data on catalytic and associated units include type, capacity, alkylation and isomerization production. G. A. C.

**683. Recent Work on Corrosion and Oxidation.** U. R. Evans. *J. chem. Soc.*, 1946, 207.—A review of recent work on the " wet " and " dry " corrosion of metals is given with particular reference to the oxidation of iron and zinc. An electrometric study of oxidative filming reactions at high temperatures has shown that the effect of temperature on the variation of film thickness with time is parabolic or exponential, according to the temperature. By a study of the effect of impurities on the electrical conductivity, it has been found that selective oxidation treatment of alufninium in a Cu–Al alloy will render the copper highly resistant to high temperature oxidation.

The mechanism of corrosion of iron and other metals in oxygen-containing salt solutions is described and shows that, whereas a discontinuous coat of metal which is cathodic to iron is highly corrosive, a metal (*e.g.*, Zn) which is anodic to iron is very protective and, when applied as paint to a rusty surface, will even prevent further corrosion. A discussion of inhibitors shows that anodic inhibitors, although more efficient than cathodic inhibitors, are dangerous if added in insufficient amount owing to intensified corrosion. B. H. K.

**684. Measuring Material Characteristics by the Penetron.** R. C. Granner. *Petrol. Times*, 27.4.46, **50** (1272), 438.—The Penetron is an instrument utilizing penetrating gamma rays which rapidly and accurately provides inspection data on lines, vessels

and their contents without injury to the material being inspected. It also determines density of liquids and locates liquid levels or the interface between two immiscible liquids, without access to the interior of the containing vessel. The principle of the operation briefly is this :—the radiation detector is placed against the wall of the line or vessel upon which measurement is to be taken. The gamma rays, which are constantly emitted from the radium source, impinge upon the vessel wall and actually penetrate this wall. A portion of these rays is scattered in all directions by the electrons of the atoms which make up the wall. Some of these scattered rays emerge on the same side of the wall from which they originally entered. It is this particular portion of the radiation, termed back-scattered radiation, which is utilized in the Penetron's Conventional Detector, for measuring wall thickness. By measuring the intensity of the back-scattered radiation by means of the detector, it is possible to determine the thickness of the wall, since for a wall of any given composition the intensity of the back-scattered radiation increases as a direct function of the wall thickness. Calibration curves for various metals and materials are supplied with the instrument. Photographs illustrate the instrument and its use. A. H. N.

## Distillation.

**685. Process Development and Production of Isohexane and Isoheptane as Aviation Fuel Components.** S. F. Birch, P. Docksey and J. H. Dove. *J. Inst. Petrol.*, April 1946, **32** (268), 167–205.—Early in 1940 the main components of 100-octane fuel were either hydrocarbon fractions isolated from crude by physical means, such as distillation or solvent extraction, or, alternatively, were hydrocarbon fractions produced by synthetic processes, such as pyrolysis, alkylation and catalytic polymerization followed by hydrogenation. Components such as these were then blended with a suitable base stock and T.E.L. to give the final 100-octane fuel, and it was due to the difficulty experienced in the production of a suitable base stock that a programme of work was instituted which culminated in 1944 in the production of 315,000 gal/day of refined isohexane and isoheptane fractions, representing about 35% of the daily output of 100-octane aviation fuel from the Anglo–Iranian Oil Company Refinery at Abadan. The output of these two components is obtained from eight fractionating units, each 12 ft in diameter, four being fitted with 50 bubble-trays, two with 76- and 100-plate units were built as double columns, so that there are twelve columns in all, varying between 120 and 140 ft in height. The complete super-fractionation installation, including staging, exchangers, pumps, and pipework, represents 6300 short tons of steel, which is equivalent of 0·7 ton steel/brl/day of useful product. A. H. N.

**686. Toluole Recovery.** Anon. *Chem. Tr. J.*, **118** (3077), 593.—A report of a meeting of the Coke-Oven Managers Association at which an azeotropic distillation process for the production of high gravity nitration toluole from low-gravity benzole, was described. With a crude toluole, distillation with methyl alcohol as an entraining agent brings over in succession, non-aromatic hydrocarbons of increasing boiling point up to 125° C, then toluene plus hydrocarbons boiling *ca* 125° C and finally hydrocarbons of still higher boiling point, each fraction containing methanol. For the production of high-gravity nitration toluole from such a raw material, it is unnecessary to remove the higher boiling impurities by means of the entrainer since, if they are left behind with the toluene, it can readily be separated from them by normal fractionation after an acid wash to remove saturated hydrocarbons and sulphur compounds.

Using the same method, non-aromatic hydrocarbons can be separated from benzene, from xylene and from higher hydrocarbons. T. M. B. M.

## Absorption and Adsorption.

**687. Practical Refrigeration for Natural Gasoline Plants.** R. W. Heath, J. B. Taylor, Jr., and P. W. Hill. *Oil Gas J.*, 23.2.46, **44** (42), 128.—Consideration is limited to the use of propane as a refrigerant and to the application in low-pressure absorption plants with absorber pressures of less than 100 psi.

The advantages of refrigeration lie in the better separation of the fixed gases from the fat-oil tank and wherever colder temperatures are developed. The cost of installing such a unit is small, and the benefits are easily appreciated in existing plants where it

is necessary to increase plant capacity for the purpose of extracting additional light hydrocarbons or to regain a plant efficiency that has been reduced owing to additional load.

In addition to the saving in first costs for a refrigeration system cooling the lean absorption oil there is a definite saving in operating costs, since the fuel requirements of the refrigeration plant are limited to engine fuel and are nominal, while to increase the capacity of the plant by heating and pumping increased quantities of absorber oil would entail a considerably higher fuel bill. The design of suitable refrigeration plant is discussed with a certain amount of operating data. D. L. S.

## Solvent Refining and Dewaxing.

**688. Propane Deasphalting Process.** C. W. Kraemer. *Oil Gas J.*, 30.3.46, **44** (47), 228.—A 14,250 brl propane deasphalting unit is described. This unit of the Cities Service Refining Corpn is sited at Lake Charles, La., and is the first commercial plant to be employed for recovering virgin heavy gas oil catalytic cracking feed stock from crude residuum. The process yields a stock having 2% or less of residual carbon and less than 2 lb salt per 1000 brl of oil. Propane to oil ratio of about 4 : 1 is used, the mixture is kept in the liquid state in the settlers, a pressure of 505 psi being used, with operating temperatures within 150–175° F. Propane is flashed off from the asphalt-propane phase, the vapours being condensed and returned for recycling, the remaining propane being removed from the asphalt in a vertical stripper.

The deasphalted gas oil propane phase is taken over-head from the asphalt settlers and the propane flashed to the propane condensers successfully in two low and two high temperature steam kettles remaining traces of propane being steam stripped. The propane free deasphalted gas oil is pumped from the stripper to storage.

G. A. C.

**689. Lubricant Stocks Improved by Propane Deasphalting.** J. T. Dickinson and N. R. Adams. *Oil Gas J.*, 30.3.46, **44** (47), 185.—The propane deasphalting process is reviewed from the standpoint of applications and development to date, and future potentialities are explored.

The first commercial propane deasphalting plant was installed in 1934, eight are now in operation, producing a clean deasphalted oil, the asphalt obtained being used as a base material for special asphalt products and road oils.

In the " stage " type unit the reduced crude and liquid propane streams are combined, mixed and heated to a predetermined temperature which causes the asphalt to form a low-ratio phase. The mixture of phases is separated continuously and a deasphalted oil solution withdrawn from the top and an asphalt solution from the bottom of the settling vessel. Some plants have two or more stages of precipitation, and equipment for acid treating and neutralizing. The use of a single solvent with stage deasphalting oil improves the viscosity index but leaves a severe decolourizing problem. The propane tower deasphalting process overcomes this and produces a catalytic cracking charge stock. The plant is of the stage type and operated in a manner similar to the stage deasphalting units used on lubricating oils, and it is likely that more tower units will be installed.

A vertical baffled tower replaces the settling vessels of the stage process ; the propane being introduced near the bottom of the tower, and deasphalted oil solution removed from the top and asphalt solution from the bottom, the solution temperatures in the tower being controlled, 67% of the deasphalted oil and 33% of asphalt being produced.

The process allows almost any crude being used as a potential lube crude, and after tower deasphalting any reduced crude can be extracted by a single solvent, and the use of clay for improving colour is seldom necessary. The asphaltic material produced has unusual characteristics which adds to the net return. Propane fractionation yields lower carbon residue products which can be more economically refined.

The process has been developed for the preparation of charging stock from various gas oils for catalytic-cracking units. Propane decarbonizing gives the highest gasoline yields of any process. A study of costs shows that the delayed coking and propane decarbonizing processes are highly competitive and more attractive financially than vacuum distillation as a method of preparing such charging stock, in both the Chicago and Gulf Coast areas, where differing economic conditions prevail. G. A. C.

**690. Secrets of German Lubricating Oil Technology in Wartime. The Highlights of C.I.O.S. and B.I.O.S. Reports to Date.** C. I. Kelly. *Petrol. Times*, 16.3.46, **50** (1269), 272. **Part II. Lubricating Oils.** *Manufacturing Process:* (a) *Petroleum.*—This section deals with the manufacture of lubricating oils made from petroleum crudes as opposed to synthetic products which will be considered separately.

A. *General Processes.*

The rapid developments in refining during the 10 years prior to the war made it possible for the petroleum industry to satisfy the demands for more and better lubricating oils. The flexibility of solvent-extraction and dewaxing processes enabled German German refiners to obtain a wide variety of products from their own and Austrian crudes.

B. *Solvent Extraction Processes.*

I. *Edeleanu Process.* Edeleanu units were in operation at the Shell refineries at Hamburg and Harburg, and the oils produced were utilized in preparing Aeroshell Mittel (85% Edeleanized oil + 15% Voltol); in a low temperature aerogrease, a hydraulic oil and in a blend with synthetic oil for the Luftwaffe. After the failure of the imported Venezuelan oils these plants were supplied with distillates from German and Austrian crudes.

Edeleanu extraction was also used for the production of a high quality diesel fuel and a high quality hard wax from brown coal tar. This was carried out at the Espenhain Works (A. G. Sachsische), which produced annually 64,000 tons diesel oil, 71,000 tons fuel oil, 13,000 tons each of hard and soft paraffin waxes and 12,000 tons electrode coke. The waxes were sold for the manufacture of fatty acids, soaps and lubricating oils.

II. *Duosol Process.* There was a Duosol unit at the Vacuum refinery, Bremen, which operated with a two-stage extraction process, the first giving a half-raffinate which in the second stage was separated into H.V.I. and L.V.I. lubricating oils. Duosol oils were used mainly as components for aero oils.

III. *Furfural Process.* There was a Furfural unit in the Nerag refinery, Misberg, and this process was also intended for use at five " Biber " and the " Dachs " underground refineries.

IV. *The Phenol Process.* As a single solvent extraction process, this was applied at the Lutzkendorf refinery to distillates and deasphaltised residuals.

V. *Propane De-asphaltizing.* This was used at the Lutzkendorf and Nerag refineries.

*New Solvent Extraction Processes.*

A considerable amount of fundamental research was done at the Reichinstitut für Erdölforschung, Hanover.

1. *De-asphaltizing.* It is reported that a unique solvent mixture—90% dioxane and 10% formic acid—was very successful in extracting asphalt from oils when used in equal proportions with oil at 5° C.

2. *Solvent extraction of brown coal tar distillates with HF.* Some work was carried out on the extraction of a diesel oil fraction from brown coal tar with HF. Time of contact had no increasing effect after 60 min, temperature of extraction was usually 18° C (b.p. technical grade HF is 21° C) and solvent/oil ratio 1 : 2. No corrosion difficulties were found in the laboratory using mild steel equipment.

3. *The Mirasol Process.* This work was carried out at the " Shell " Research Dept., Amsterdam, during the German occupation. Solvent extraction with antimony trichloride at its melting point (about 80° C) with oil/solvent ratio 1 : 1 was investigated. Losses of antimony trichloride per single operation is stated to be 0·1%.

4. *Process for Separating Naphthenic and Paraffinic Fractions.* Separation of high boiling oils is done by fractional distillation in the presence of azeotrope-forming materials (*e.g.*, bitumen). The use to which this process was put is not entirely clear.

5. *Removal of Oil from Synthesis-wax by Selective Solvent-extraction.* This work was in process at the Ruhrchemie's research laboratories (Sterkrade-Holten) with the object of preparing hard paraffin wax (m.p. 90° C) and a slab paraffin wax (m.p. 50–52° C) from crude wax. The most important solvents were reported to be acetone and petroleum solvents of different boiling ranges.

6. *Extraction of Coal Tars in the Cold.* This has been studied by Metallgesellschaft-

Lurge who were constructing plants for this purpose at Hirschfelde and Altenburg. The work and processes had for their objective : (*a*) extraction of brown coal tar with amyl and butyl acetates to remove phenols ; (*b*) extraction of 200–350° C fraction with MeOH to give phenols and a diesel fuel–cetane no. of 15.

C. *Solvent Dewaxing Processes.*

I. *Edeleanu Dewaxing Process.* This process has undergone marked changes in Germany during the war, the solvent formerly liquid $SO_2$ and benzol being changed in one plant to ethylene chloride and in others to a mixture of methylene and ethylene dichloride.

The plant at the Espenhain works of A. G. Sachsische shows several interesting features, chief among which is a two stage process using ethylene dichloride, claimed to give a hard wax of very low content and a unique design of " band filter " used for the hard paraffin dewaxing stage.

II. *Acetone–Benzol Dewaxing Process.* An improvement tried on a pilot plant scale at the Vacuum's Oslebshausen refinery involves a modification of the Dorr–Oliver filtration process to obtain higher filtration rates.

III. *The " Barisol " Dewaxing Process.* A change of solvent is reported from Oppau where it was intended to use butyl alcohol instead of the usual ethylene dichloride.

*New Dewaxing Solvents.*

From the Reichinstitut für Erdölforschung, Hanover, comes a report that hydrazine derivatives are particularly good for the separation of wax from an oil. D. L. S.

**691. Secrets of German Lubricating Oil Technology Revealed. The Highlights of C.I.O.S. and B.I.O.S. Reports to Date.** C. I. Kelly. *Petrol. Times*, 30.3.46, **50** (1270), 318. **Part II. Lubricating Oils.** *Manufacturing Process* : (a) *Petroleum.—The Edeleanu Objective.* This article deals almost exclusively with the C.I.O.S. Report XXXI-85 on the Edeleanu G.m.b.H. Altenburg, a large portion of which is devoted to a translation of a lecture delivered by Professor Terres of the Edeleanu Co. on June 6, 1942, to a committee of the German Brown Coal Industrial Organization.

In 1936 the Edeleanu Co. undertook the complete separation of L.T.C. tars by a continuous process into diesel oil, heating oil, and oil-free hard wax and an oil-poor soft wax. The whole scheme is presented diagrammatically in this review.

The raw tar is distilled into electrode coke, a wax-free distillate and a waxy redistillate. $SO_2$ extraction of the waxy distillate in three stages takes place and the raffinate is naphtha washed at $-10°$ C and then dewaxed with dichlorethylene. The only new apparatus involved was a closed continuous band-filter for dewaxing.

The products included diesel oil I with cetene number 60–75 and diesel oil II cetene number 35–45, heating oil miscible in all proportions with other heating oils density >1·00 and waxes which refined easily.

The article described the research programme of the company and discusses the theories underlying the process. D. L. S.

## Cracking.

**692. Catalytic Refining.** Anon. *Oil Gas J.*, 30.3.46, **44** (47), 135.—A thirty-two page multicolour section contains a graphic presentation of the most important catalytic refining processes, including Cycloversion, Fluid, Houdry, Suspensoid, Thermofor, Hydroforming, H.F. Alkylation, Sulphuric Acid, Isomerization, Desulphurization and Polymerization. Product yields and properties are tabulated for each type of process using different charge stocks. It is shown that the fixed-catalyst bed Houdry process cracks to produce 45–60% gasoline of 76–80 A.S.T.M. octane number, furnace oils and diesel fuels. The fixed-bed Cycloversion process gives approximately the same results. The principle of a fluid catalyst is applied to crack oils at high throughputs. The Thermofor process moves a solid catalyst bed through the reaction zone. The Suspensoid process mixes catalyst and charge. Both natural and synthetic catalysts are used, each with certain advantages. HF or $H_2SO_4$ alkylation unite olefin and isoparaffin to make superfuels for aviation and reduce vapour pressures of light hydrocarbons. Isomerization produces isoparaffins and improves octane ratings of naphthas

10 to 30 numbers. Hydroforming aromatises naphthas and increases octane 10 to 30 numbers. Polymerization lowers vapour pressure of too light olefins and makes high anti-knock polymer. Desulphurization reduces corrosion tendencies and improves T.E.L. susceptibility. G. A. C.

**693. A Fluid Catalytic Cracking Unit for the Smaller Refiner.** D. Read. *Petrol. Times*, 27.4.46, **50** (1272), 426.—The development of a simplified fluid catalytic cracking unit for the smaller refiner is described. The principal improvements in efficiency and the mechanical simplifications which have been made are listed below :—(1) The reactor and regenerator have been combined into a single vessel which is erected as a self-supporting column in the smaller sized units; (2) When microspherical catalyst is used all secondary catalyst recovery equipment, such as the Cottrell precipitator and a slurry settler or slurry circulating system on the processing side, has been eliminated; (3) The efficiency of both the reactor and regenerator has been improved by the use of additional distribution grids in each section; (4) The redesign of the reactor stripper, the installation of an external stripper, and the additional stripping obtained in the counter-current regenerator results in a marked improvement in stripping efficiency and a reduction of regeneration requirements. The improved method of controlling the new unit results in uniform catalyst flow and smooth operation. This method of control has been tested in the 2600 brl/day commercial unit.

The flexibility of the fluid catalytic cracking process has been demonstrated by commercial units, which have processed stocks ranging from naphthas to topped crude at reactor temperatures of 600–1000° F. Various recycling operations and combinations of catalytic and thermal cracking operations have been investigated in both pilot plant and commercial units. The reduced investment and operating costs now permit this process to compare favourably with thermal cracking investment and operating costs. A. H. N.

**694. Comparison of Bead and Clay Catalysts.** L. P. Evans. *Oil Gas J.*, 30.3.46, **44** (47), 167.—The relative merits of bead and clay catalysts used in T.C.C. plant operation are discussed.

The cost of clay catalyst is $100 per ton on a dry basis as against $240 per ton for the dehydrated beads.

The make-up rate for beads is 1 to 1½ tons per day, for clay it is 3 to 4 tons per day. Catalyst losses are greatly effected by attrition resistance and crushing strength properties; laboratory tests indicate that the bead type is superior.

Initially, bead catalyst costs more but make-up requirements are less. Clay catalysts deteriorate at 1450° F, whereas the bead type can be safely heated in air to 1700° F, and initially bead catalysts have higher initial activity and better ageing characteristics. Commercial T.C.C. experience shows that bead units with lower make-up requirements maintain equilibrium activity at about four points higher than clay. Both laboratory and plant data show that beads yield a more favourable product distribution than clay, for example, the substitution of beads for clay in a 10,000-brl per day plant, gave 260 brl per day more of total liquid products.

Beads result in improved gasoline quality in T.C.C. operations with higher yields. On a 10,000-brl unit, beads show consistently higher process earnings than clay, approximately $1000 per day, thus the incremental cost of the initial batch of bead catalyst can be written off, in less than three months.

With abnormal stocks, high in sulphur and nitrogen compounds, which exert a severe poisoning action on clay catalysts with 40% increase in coke production, the bead type is not affected, a normal yield pattern over the entire range of 30 cycles being maintained.

Changes in bead catalyst manufacture which raised the sodium content, improved the ageing properties and thus will increase the over-all catalyst performance.

A number of tables and figures fully illustrate the comparisons of product yields and properties of the two catalyst types. G. A. C.

**695. Cat-Cracking Feed Stock Improved by Delayed Coking.** R. B. Tuttle. *Oil Gas J.*, 6.6.46, **44** (48), 109.—A recent report on the delayed coking process is discussed.

A 30% reduced crude yielded more than twice as much cracked gasoline, one-sixth more gas oil and no tar when processed by the delayed coking method. Coke removal

is accomplished by hydraulic jets operated from above the coke bed, a product free from contamination and ready sized being obtained.

The modern delayed coking process differs from conventional thermal cracking in that quickly heated topped crude enters an insulated coking drum at high temperature and is coked by its contained heat, the pressure being from 5 to 50 psi dependent on feed stock and desired yield. High flexibility allows for controlled variation in products to suit market conditions, for example, gas oil boiling range may be varied by altering coking temperature and pressure.

The alternate charging, coking and cleaning of the service drums in the coking section gives a constant throughput process, the cleaned drums being preheated before cutting into service again. G. A. C.

**696. Addition of One Coil Increases Cracker's Efficiency by Two-Thirds.** B. B. Tuttle. *Oil Gas J.*, 1.12.45, **44** (30), 83.—See abstract No. 66 " First 3-Coil Thermal Cracking Unit in U.S. Goes on Stream at Sunray Refinery." (*Nat. Petrol. News, Techn. Sect.*, 5.9.45, **37** (36), R.676). W. H. C.

## Hydrogenation.

**697. German Wartime Aviation Fuels Largely Made by Hydrogenation of Coal.** Anon. *Oil Gas J.*, 16.2.46, **44** (41), 92.—This article is based on Technical Report 145–45 produced by the U.S. Naval Mission in Europe, July 1945.

The Germans made two grades of aviation fuel, B.4, or Blue grade, and C.3, or green grade, each containing 4·35 cc per gallon of T.E.L.

The B.4 grade was a fraction made from the liquid product of the hydrogenation of coal tar and contained 10–15% vol aromatics, 45% vol naphthenes and the remainder paraffins, with octane No. 89. The C.3 grade O.N. about 95, contained 10–15% synthetic isoparaffins and 85% of an " aromatized base stock " said to be made by treating coal tar hydrogenated gasolines by hydroforming operations.

At least 85% of all German aviation fuels were made up of base stock derived directly from coal and coal tar by destructive hydrogenation. Three operations were involved :—(*a*) bulk destructive distillation of coal to make tar ; (*b*) purification of this tar ; (*c*) hydrogenation of (*b*) to make gasoline, and other products which were recycled back to the reactor. The catalyst used was generally $Al_2O_3$ mixed with 10% $MoO_3$.

Two hydroforming units were operated in Germany processing Roumanian and Austrian crude oil fractions. There was no commercial catalytic cracking process in operation.

Isoparaffins were made by hydrogenation of polymerized olefins or by alkylation of isobutane with butylenes. The first process was carried out at Leuna, Ludwigshaven-Oppau and Heydebrek using isobutylene made from isobutyl alcohol itself synthesized by a variant of the Fischer Tropsch process.

The alkylation process did not materialize until 1943 and the plants as designed in Germany varied somewhat from American practice.

Four *n*-butane isomerization plants were operating using a vapour phase process with $AlCl_3$ as catalyst, this differing little from standard American processing.

D. L. S.

## Polymerization.

**698. Secrets of German Lubricating Oil Technology Revealed. Highlights of C.I.O.S. and B.I.O.S. Reports to Date.** C. I. Kelly. *Petrol. Times*, 13.4.46, **50** (1271), 369. **Part II. Lubricating Oils.** *Manufacturing Processes* (b) *Synthetic $AlCl_3$ Processes.*—Lubricating oils for the three German services were made during the war by synthetic methods using $AlCl_3$ in four main types of process.

1. Polymerization of ethylene made from ethane and acetylene.
2. Polymerization of liquid olefines boiling within the gasoline range.
3. Polymerization of paraffinic and aromatic hydrocarbons.
4. Mixed polymerization of olefin-polymer and petroleum lubricating oils (this did not reach large-scale practice).

Processes 1 and 2 were similar in their main principles and were in operation at 7 plants, while 2 additional plants had not been operated by the end of the war.

Details of operating conditions at all these plants are summarized in a comprehensive table.

The most complete report (C.I.O.S. XXXII–107) deals with the Leuna plant where ethylene was made by cracking a mixture of ethane and oxygen.

The crude ethylene was purified to remove unwanted reaction products and finally subjected to low-temperature fractionation to give a material of 95% purity. Then followed polymerization in the presence of $AlCl_3$, separation of lubricating oil from the polymerization products, and fractionation to the required specification. There were variations in the processing conditions at the different plants, some of which used ethylene prepared by alternative methods or liquid olefines made by cracking wax. In the main, bright stocks were produced by these processes and these were used mainly in the blending of aviation oils.

Process 3 was carried out at only one place in Germany, Rheinpreussen-Homberg, by the following manufacturing steps :—(*a*) Chlorination of Fischer Tropsch "Kogasin" of boiling range 250–350° C; (*b*) condensation of the chlorinated product and naphthalene in presence of $AlCl_3$; (*c*) neutralization and decolorisation; (*d*) distillation.

The oils produced ranged from spindle to cylinder oils and had a good reputation.

Process 4 had for its key principle the reaction in presence of $AlCl_3$ between a synthetic polymer and a petroleum lubricating oil distillate, which had been deasphaltized and dewaxed but not solvent refined. It was primarily developed by the I.G. Farbenind., but there is no information of the operation of the process on a large scale in any of the available reports. D. L. S.

**699. Polyethene Compared with Other Similar Macromolecular Hydrocarbons.** R. Houwink. *Brit. Plastics*, May 1946, **18** (204), 192.—The properties of polyethene are compared with those of some other high polymers of a similar type on the basis of their molecular structure. Special attention is given to mechanical behaviour, dissolving and swelling capacity, chemical resistance and electrical properties, of which last dielectric constant and dielectric losses are particularly stressed. The conception that the molecules are branched is supported. The technical merits of the material are discussed. T. M. B. M.

## Alkylation.

**700. Numerous Improvements in HF Alkylation will Cut Costs and Reduce Losses.** W. B. Shanley and H. J. Nebeck. *Oil Gas J.*, 1.12.45, **44** (30), 94.—Developments that have taken place during the first two years of commercial HF alkylation will allow easier operating, longer on-stream times, less maintenance, fewer chemicals and utilities and permit a wider range of feed stocks to be processed. The improvements and modifications are described, and operating procedures are shown by flow diagrams of :—(1) the original plant; (2) the original plant modified; and (3) the latest design, alkylation units.

The two most important improvements are modification of the HF regenerating system and the re-location of the primary bauxite defluorinating towers. It has been found that metallic aluminium decomposes the combined fluorine ($SiF_4$) produced in the system. The liberation of HF by this reaction will be of much value for its recovery from the combined fluorine contained in the deisobutanizer bottoms stream. Combined fluorine production and neutralization of bauxite has on average accounted for a consumption of 0·3 lb HF/brl of alkylate produced. Re-location of the primary defluorinating towers will reduce this consumption to 0·1 lb HF/brl or less. A similar reduction may be affected by the aluminium defluorinators. As acid consumption is reduced by this means so too will be the consumption of bauxite or its equivalent. Another economy is effected by the modifications, and is described, in respect of the water produced at the time the $SiF_4$ is formed, and which passes with the recycle to the contactors, to be expelled therefrom with its equivalent of HF. This mechanism formerly accounted for about ½ lb HF/brl of alkylate, but, by the modifications, this loss will now be eliminated.

Developments in constructional materials have brought about considerable reduction of the corrosion formerly found in pumps and equipment, this also saves acid. Through the improvements described, on-stream periods of 92% plus will accrue, and acid

consumption, exclusive of mechanical losses, will be around ¼ lb HF/brl of alkylate produced.

The developments have shown that by HF process, the less expensive olefin—propylene—produces a good grade of alkylate. Amylene can be processed either alone or with other olefins, requiring only an increased rate in the regeneration of acid and no increase in chemical consumption. W. H. C.

**701. Alkylation of Alkanes.** G. Egloff and G. Hulla. *Chem. Rev.*, 1945, **37** (323), 399.—Available literature on the subject, excluding patents, is reviewed. Reaction conditions, reactant mixture composition, catalyst and product composition data are discussed for catalytic alkylation procedures using aluminium chloride, double compounds of aluminium chloride and alkali metal chlorides, aluminium bromide, both alone and with aluminium chloride, zirconium chloride, boron fluoride, hydrogen fluoride and sulphuric acid. The use of alkenyl halides and alkyl fluorides in place of alkenes with appropriate catalysts is discussed.

Thermal alkylation reactions between $C_2$–$C_4$ alkenes and $C_3$–$C_4$ alkanes are described, with thermodynamic equilibrium data for two reaction mixtures. Differences in reactivity of individual alkanes and alkenes under conditions for catalytic and thermal alkylation are summarized. Alkylation of alkanes by methyl radicles is considered as a transition between the catalysed and thermal processes. Available data on the products of alkane alkylation reactions are analysed qualitatively and the influence of reactant mixture composition and catalyst type shown in tabular form for the alkylation of straight-chain alkanes, isobutane with $C_1$–$C_3$ alkylating agents and isobutane with $C_4$ alkylating agents, with products up to $C_{10}$–$C_{12}$ listed individually. The most frequent products are noted and gaps in experimental data indicated.

Mechanisms of catalytic alkylation proposed by seven groups of investigators are discussed. These include :—direct addition of an alkene to the tertiary carbon of an isoalkane, suggested by Ipatieff and Grosse ; a proton transfer mechanism in sulphuric acid-alkane complexes, followed by subsequent reactions, due to Birch and co-workers ; the addition of alkane fragments, formed by C–C bond scission in sulphuric acid, to alkenes proposed by McAllister *et al* ; a similar mechanism due to Cæsar and Francis involving intermolecular methyl group transfers, with comparative thermodynamic calculations of product composition ; Schmerling's theory of alkane alkylation catalysed by aluminium and hydrogen chlorides as a chain reaction involving transient conversion of alkane into alkyl chloride, addition of alkyl chloride to alkene to give a higher alkyl chloride and exchange of chlorine for hydrogen with initial alkane to give the final product ; a discussion by Bartlett and co-workers of Schmerling's theory in terms of carbonium-ion intermediates ; Ciapetta's application of carbonium-ion theory and statement of essential factors for satisfactory catalytic alkane-alkene alkylation. Radicle and hydrogen replacement mechanisms proposed for thermal alkylations are considered. G. H. B.

## Chemical and Physical Refining.

**702. Desulphurization of Petroleum Hydrocarbons.** R. M. Reed. *Oil and Gas J.*, 30.3.46, **44** (47), 219.—A summary of sulphur compounds occurring in petroleum hydrocarbons and the commercial methods available for desulphurizing is given. Compounds present include alkyl and dialkyl sulphides, carbon disulphide, carbonyl and hydrogen sulphides, mercaptans, thiophane, thiophene and thiophenol, elemental sulphur and a number of substituted and complex sulphur compounds. Hydrogen sulphide may be removed by fractionation and by chemical processes.

The Seaboard process was the first to employ a liquid absorbent that could be regenerated ; the gas is contacted with a dilute solution of sodium carbonate and removed from the solution by air blowing. The Thylox process employs sodium thioarsenate solution as absorbent, air-blowing regenerates the solution with production of elemental sulphur. The Girbotol process uses solutions of amines ; re-separation of the gas is accomplished by heating the amine solution. The Shell phosphate process employs a solution of tripotassium phosphate, and the Phenolate process absorbs hydrogen sulphide from gases by absorption in sodium phenolate. The Houdry intermittent process utilises nickel oxide at about 800° F.

Three types of processes are available for mercaptan removal :—(1) those which chemically convert mercaptans to disulphide ; (2) those which remove mercaptans and

not other sulphur compounds; and (3) those which remove some or all of the different types of sulphur compounds.

Those of the first which include doctor treatment, copper–chloride and lead sulphide processes, oxidize the mercaptans to disulphides. Processes of the second type are regenerative and actually remove the mercaptans, are similar to those described for hydrogen sulphide removal, and include the Shell Solutizer, Mercapsol and Tannin Solutizer methods. The removal of the mercaptans results in the use of less lead tetraethyl to bring the treated gasoline to the required octane value, than by processes described under Type 1. With either type the prior removal of hydrogen sulphide is necessary. With Type 3, which includes sulphuric acid treating, catalytic desulphurization processes and catalytic hydrogenation processes; previous removal of hydrogen sulphide is not essential, although desirable. The Gray catalytic process uses clay as catalyst, and the Perco employs bauxite. Catalytic-hydrogenation processes for desulphurization operate in the same way as catalytic desulphurization except that hydrogen is added to aid in the conversion of organic sulphur compounds to hydrogen sulphide, the excess hydrogen being removed by fractionation or oil absorption. These processes are utilized where the sulphur content is either high or not easily removed. Carbon disulphide and carbonyl sulphide may be removed by alcoholic caustic solution or by the catalytic processes previously mentioned, and elemental sulphur by fractionation or doctor treatment. G. A. C.

## Metering and Control.

**703. On Dimensional Analysis and the Presentation of Data in Fluid-Flow Problems.** E. R. Van Driest. *J. Appl. Mech.*, March 1946, **13** (1), A34–A40.—The method and application of dimensional analysis are discussed, making use of the fundamental concept of function. The $\pi$-theorem is re-stated and proved in general form. Pipe friction, drag of spheres, and flow through Venturi meters are examples used to illustrate the rearrangement of dimensionless products of a relationship to obtain the most convenient form for presentation of data. A. H. N.

# Products.

## Chemistry and Physics.

**704. Physical Properties and Chemical Constitution. Part IX. Aliphatic Hydrocarbons.** A. I. Vogel. *J. chem. Soc.*, 1946, **133**.—Further data is given for parachors and refractive indices using C, D, F and G lines of normal and some branched chain hydrocarbons from which the corresponding physical constants for $CH_2$, H and C are deduced. (*J.C.S.*, 1943, 18.) Detailed preparations of the hydrocarbons ($n$-pentane to $n$-hexadecane) in a high degree of purity are described. B. H. K.

**705. The Antoine Equation for Vapor-Pressure Data.** G. W. Thompson. *Chem. Rev.*, 1946, **38**, 1–39.—A large number of equations, either empirical or with a semi-theoretical basis, that have been used to relate vapour pressure and temperature data for pure liquids and their mixtures, over both restricted and extended temperature ranges, are critically reviewed. The equations of Cox, Blot, Gamson and Watson are considered to be most satisfactory for use over the entire liquid range, up to the critical temperature. For practical purposes two Antoine equations of the form $\log P = A - B/(t + c)$ are recommended, the first up to a reduced temperature of 0·75, and the second from this point to the critical point. Simple methods are described for computing the empirical constants from experimental data, including rules for estimating the value of $C$. For organic compounds which are liquid at room temperature, an average value of $C = 230$ is used to construct a nomograph for 55 substances, including hydrocarbons, alkyl and alkylene halides, alcohols, esters, ethyl aviation and motor fluids, lead-, aluminium-, bismuth- and mercury-alkyls, and related organometallic compounds. Individual Antoine equations of high or moderate precision are tabulated for 28 substances, including several hydrocarbons and a separate table lists the three constants of the Antoine equations for all the $n$-paraffins from $C_1$ to $C_{19}$. The use of Antoine equations for the calculation of heats of vaporization is described

in detail, and its application to the representation of other temperature-dependent properties of liquids indicated briefly. 59 literature references are quoted.
G. H. B.

**706. The Theory of Plasticity—An Outline of Work Done in Russia.** W. W. Sokolovsky. *J. Appl. Mech.*, March 1946, **13** (1), A1–A10.—Whilst the paper deals particularly with plasticity in soils and solids, its concepts may be found applicable to the rheology of petroleum products in a number of uses or conditions. The theory of plasticity, as an important part of the mechanics of continuous materials, has occupied the attention of many Russian workers in recent years. In the first paper in this field, published in 1935 by S. Sobolev, the propagation in time of a plastic zone was investigated around a circular hole in an infinite plate. The plastic zone was assumed to have a polar symmetric shape. Based on the works of L. Prandtl, Th. von Karman, R. von Mises, H. Hencky, A. Nadai and others, more recently a group of young Russian engineers have investigated further the theory of plasticity and added many new developments to it. While the investigations abroad and in Europe, outside of Russia, were being aimed at establishing the validity of the theory of plasticity, most of the papers appearing in the literature in Russia were devoted to the solutions of concrete problems. This review does not attempt to discuss broadly the work done in the theory of plasticity. The author confines himself to certain parts of the theory which have been developed in Russia. Naturally those closest to his own scientific interests have been selected for treatment. These are examples of soil formations subjected to various types of stresses and with the distribution of stress in plates with holes of various shapes.
A. H. N.

**707. An Experimental Comparison of the Chemical Effects of Deuterons and of Alpha Particles on Methane and *n*-Butane.** R. E. Honig and C. W. Sheppard. *J. Phys. Chem.*, March 1946, **50** (2), 119–143.—An experimental comparison of the chemical effects of deuterons and alpha particles on methane and *n*-butane has been carried out. The principal gaseous products from both types of bombardment were paraffin hydrocarbons and hydrogen. A comparison of the complex liquid product obtained from butane was made only for those properties which could be determined on small quantities. The larger quantities of liquid obtained from the deuteron bombardments were distilled and the resulting cuts studied. A wide range in molecular weights is indicated. Evidence is obtained for the presence of olefin and ring structures. The mean energy dissipated/molecule decomposed, termed the dissociation expenditure, is computed in all cases. Its use eliminates difficulties encountered in calculations of ionization. While it is obviously impossible to prove the complete identity of the chemical effects of deuterons and alpha particles, it has been shown in this experimental comparison that these effects are very similar. Thus it appears that the deuteron beam is a most valuable adjunct to naturally radioactive sources, especially where large amounts of conversion products are required.
A. H. N.

**708. A Theoretical Analysis of the Relative Chemical Effects of Alpha Particles and Deuterons.** C. W. Sheppard and R. E. Honig. *J. Phys. Chem.*, March 1946, **50** (2), 144–152.—The relative chemical effects of alpha particles and deuterons are compared from a theoretical point of view. A review is made of the existing information concerning the manner in which the energy of the incident particles is distributed in the reacting system. Evidence is presented which indicates that the energy absorption is predominantly an electronic process, and that the energy is distributed among the various states of excitation and ionization of the reacting system in a manner which is independent of the charge and mass of the bombarding particle and only slightly dependent on its velocity. An explanation is advanced for the frequently observed fact that chemical reactions occur in properties to the ionization produced in the system.
A. H. N.

**709. Purification and Properties of 29 Paraffin Alkyl*cyclo*pentane, 10 Alkyl*cyclo*hexane and 8 Alkylbenzene Hydrocarbons.** A. F. Forziati, A. R. Glasgow, Jr., C. B. Willingham and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, February 1946, **36** (2), 129.—The results are given of the purification and measurements of refractive index ($n_d$ at 20° and 25° C), boiling point and pressure coefficient of the boiling point (at 1 atm) and,

except for four of the compounds, the freezing point, together with the calculated amount of impurity, of samples of 51 hydrocarbons. The paraffins examined are :— 2 pentanes, 5 hexanes, 3 heptanes, 17 octanes, *n*-nonane, and *n*-decane; the alkyl*cyclo*pentanes: *cyclo*pentane and its methyl, *n*-propyl and isopropyl derivatives; the alkyl*cyclo*hexanes; *cyclo*hexane and its methyl and ethyl derivatives, together with *cis*- and *trans*-1 : 2-, 1 : 3-, and 1 : 4-dimethyl*cyclo*hexane as well as the *n*-propyl derivative. The alkylbenzenes include benzene toluene, ethylbenzene, the three xylenes and *n*- and isopropylbenzene. T. M. B. M.

**710. The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds. Part XI. Double Bond Movement During the Autoxidation of a Mono-olefin.** E. H. Farmer and D. A. Sutton. *J. chem. Soc.*, 1946, 10.—An attempt has been made to confirm the mechanism of hydroperoxide formation in the autoxidation of polyisoprene and similar $\Delta^{1:4}$-dienes by following the hydroperoxidation of 1 : 2-dimethyl-$\Delta^{1}$-*cyclo*hexene. (See Farmer, *et al*, *J.C.S.*, 541, (1943).) The hydroperoxides, formed by photo-oxidation of the *cyclo*hexene, were reduced with a platinum–palladium catalyst to give isomeric secondary and tertiary alcohols which were isolated and identified.

Further action of aqueous alkali on 1 : 2-dimethyl*cyclo*hexene-3-hydroperoxide gave the same dihydroresorcinol as did 1-methyl*cyclo*hexene-3-hydroperoxide (*i.e.*, 2-methyl-*cyclo*hexane-1 : 7-dione). It is suggested that this compound, which was isolated and identified, is probably formed by oxidation by active oxygen formed in the decomposition of the O·OH groups by the mechanism referred to above. B. H. K.

**711. Synthesis of : (1) Glycerol and Propylene Glycol from Propylene, and (2) Ethylene Glycol from Ethylene.** D. M. Newitt and P. S. Mene. *J. chem. Soc.*, 1946, 97.—The formation of polyhydric alcohols by oxidation of corresponding olefins at high temperatures and pressures is described. A pressure of about 70 atm and a temperature of about 230° C appears to give fairly good yields of propylene glycol and glycerol from propylene. A possible mechanism involving the intermediate formation of an oxide is postulated. B. H. K.

## Analysis and Testing.

**712. The Evaluation of Unsaturation in Mixtures of Hydrocarbons (Motor Spirits) by the Use of Pyridine Sulphate Bromide.** G. E. Wilson and H. B. Nisbet. *Analyst*, 1946, **71**, 183.—The application of pyridine sulphate bromide reagent, originally developed by Rosenmund and Kuhnhenn for the determination of the iodine value of fatty oils, and later adopted as the standard reagent for measuring the unsaturation of the unsaponifiable fraction of fatty oils, is claimed to give a rapid and reliable measure of unsaturation in hydrocarbons of the motor spirit type.

It is stated that the inherent disadvantages of variable substitution reactions in the McIlhiney method and of varying excess of reagent in the Francis method are overcome by the use of this method

Table I shows the results obtained by each of the three methods on thirteen samples of hydrocarbon materials.

Table II summarizes the application of the method to synthetic hydrocarbon mixtures containing known amounts of olefines and shows the widely varying excess of reagent used in the determinations.

The results quoted show good repeatability and agreement with the theoretical olefine content.

A brief outline of the method is supplemented by a bibliography of nine references. B. W. S.

**713. Determination of Aromatics, Naphthenes and Paraffins by Refractometric Methods.** R. M. Gooding, N. G. Adams and H. T. Rall. *Industr. Engng Chem. Anal.*, 1946, **18** (1), 2–13.—Group analyses of ten American crude-oil naphthas are given, calculated from specific dispersions and refractivity intercepts obtained on narrow-boiling distillate fractions. The experimental methods used, based on the work of previous authors, are described in detail. A. W.

**714. Analysis of Ternary Mixtures of Methyl*cyclo*hexane–Toluene–Aniline.** C. S. Carlson, A. E. Schubert and M. R. Fenske. *Industr. Engng. Chem. Anal.*, 1946,

**18** (2), 109–111.—A method of analysing the ternary mixture methyl *cyclo*hexane–toluene–aniline has been developed, based on refractive index determinations before and after acid extraction for the removal of aniline. With the aid of an experimentally established curve the ternary analysis can be found. A. W.

**715. Apparatus for the Flash-Distillation of Butadiene.** A. P. Hobbs and H. R. Rector. *Industr. Engng. Chem. Anal.*, 1946, **18** (2), 140–141.—An apparatus for the flash distillation of butadiene is described. Its efficiency has been determined with the aid of the Darell weathering-test apparatus. Substantially complete removal of butadiene dimer is accomplished without appreciable loss of $C_5$ hydrocarbons. A. W.

**716. The Amperometric-Titration of Mercaptans with Silver Nitrate.** I. M. Kolthoff and W. E. Harris. *Industr. Engng. Chem. Anal.*, 1946, **18** (3), 161–162.—A simple amperometric titration method for the routine determination of primary, secondary and tertiary mercaptans with silver nitrate in the presence of ammonia is described using the rotating platinum wire electrode. Amounts of mercaptan sulphur as small as 0·2 mg can be analysed with an accuracy of 1 or 2%, the time required for each titration being about 2 minutes. Large amounts of bromide, as well as cyanide and other ions which yield insoluble silver salts in ammoniacal medium, interfere with the determination. A. W.

**717. Colorimetric Determination of p, p′-DDT in Technical DDT.** S. W. Chaitrin. *Industr. Engng. Chem. Anal.*, 1946, **18** (4), 272–273.—A colorimetric procedure is described for the determination of p, p′-DDT.; it is based on the colour produced when this compound is heated in a mixture of glacial acetic and concentrated sulphuric acids. The method is applicable to the estimation of p, p′-DDT in mixtures with the o, p′-isomer and in technical DDT when a small correction is made. A. W.

**718. Laboratory Determined Pour Points of Lubricating Oils as Related to Ability to Flow under Field Storage Conditions.** J. J. Giammaria. *A.S.T.M. Bull.*, Jan. 1946, **138**, 44.—This paper reviews the work of A.S.T.M. sub-committee No. XVI on Cloud and Pour Test with particular reference to "pour point reversion."

In the 1945 Report of Committee D-2 a method was proposed for determining "Maximum Pour Points of Lubricating Oils Containing Pour Point Depressants." This method has now been compared with A.S.T.M. D.97, "S.O.N.J. Type V Test" and with results obtained with limited field testing.

It is concluded that the new proposed test is more reliable than any yet published, and shows 63% agreement with field tests as against 10% for D.97 and 37% for the Type V test. It requires only the ordinary pour test equipment and can be performed in 6–8 hours, whereas the Type V test requires about a week to run and utilizes elaborate equipment. On the other hand the Type V test shows a somewhat better relationship between stable pour point determinations and the frequency of solidification in the field.

The proposed A.S.T.M. test is quite consistent in giving warning in the case of very unstable oils, but such warning is not consistently justified for all oils. D. L. S.

**719. Acid Flocculation Test.** W. A. Proell and J. A. Bolt. *Oil Gas J.*, 30.3.46, **44** (47), 234.—A method for determination of gum content of heavy distillate fuel oils is described. Previous attempts to devise a method were based on evaporation at relatively high temperatures in the presence of an inert gas. The method described is based on the theory that the gum which deposits in fuel systems is present in the oil as a colloidal dispersion and can be flocculated by hydrochloric acid. No chemical change is caused in the oil itself. The oil is contacted with the acid, the floc filtered out, washed free of oil and weighed. The diatomaceous earth used in the test must be freed from traces of iron since iron compounds are gum-forming catalysts. Oil soluble materials, irrespective of molecular weight, are not measured as gum.

A wide range of fuels were examined and duplicate analysis on high-gum stocks give results within 2% of the total gum content. The test is regarded as suitable to distinguish between gums and heavy, low volatility hydrocarbons present in the oil. G. A. C.

## Gas.

**720. Liquefied Petroleum Gas Industry and Its Peacetime Problems.** F. L. Fisher and J. W. Vaider. *Pet. Engr*, Jan. 1946, **17** (4), 116.—A survey of the present position of the liquefied petroleum industry is presented and a forecast of trends for 1946 is given. From the published P.A.W. figures for 1945, the peak demands amounted to 25 million gal/month, for synthetic rubber production; 200 million for aviation gasoline components, and 16 million gal/month for chemical manufacture, about half being propane, excluding the amounts pipe transported for this purpose which is considered to be more than double this figure. The offtake for synthetic rubber may be expected to continue at a high rate for some time, the release of butanes–butylenes anticipated by a lessening demand for aviation needs will be used: (1) to boost volatilities of motor fuels to pre-war levels; (2) via, polymerization, alkylation and polyforming operations for improvement of octane values of motor fuels, consumption for chemical manufacture will rise to satisfy an ever growing market.

Other uses for liquefied petroleum gases are:—butanes–butylenes for gas enrichment and to accommodate peak loads, domestic heating and cooking will call for larger volumes, and their use in internal combustion engines will probably increase. A study is in progress of their use as fuels for air-conditioning apparatus, particularly as applied to railway equipment. Some aspects of their use in agriculture are outlined.

W. H. C.

**721. Liquefied Petroleum Gas in 1945.** G. G. Oberfell and R. W. Thomas. *Petrol. Engr*, Jan. 1946, **17** (4), 59.—See Abstract No. 618 (*Oil Gas J.*, 12.1.46, **44** (36), 64).

W. H. C.

## Lubricants.

**722. Silicones as Lubricants.** T. A. Kauppl and W. W. Pederson. *Nat. Petrol. News, Tech. Sect.*, 5.12.45, **37** (49), R.944.—The many uses for silicone fluids are given and the physical properties of five types are tabulated and discussed. Their viscosity temperature slopes are plotted in comparison with two petroleum products. S.U. viscosities range from 29 to 3960 seconds at 100° F.

It is claimed that silicone fluids possess superior heat stability, oxidation resistance, non-volatility and viscosity index qualities to petroleum oils. The tests reported show that variations in chemical composition greatly affects their lubricating properties. Some, however, approach petroleum oils in their ability to reduce wear, but even the best is not an E.P. lubricant. A new wear test machine is described and two series of tests with silicone fluids and various metal and alloy test pieces, in comparison with petroleum oils are reported. The best silicone fluid, DC.710, showed less loss than an S.A.E. 10 oil, up to 2000 gr loads, but twice as much wear under 300 gr loads. Under 1500 gr load this gave considerably less wear than S.A.E. oil at all running times up to 16 hours. The tentative conclusion drawn from the tests is that the DC. 710 fluid is better than the petroleum oil for steel to brass at moderate loads, but less effective than petroleum oil at loads approaching extreme pressure range. With soft steel test piece, for the same time and 1500 gr and 4000 gr loads, the silicone fluids DC. 200 and DC. 510, are quite poor. DC. 550, slightly better and DC. 710, seemed to be equivalent to petroleum oil of about the same viscosity. Various metals and alloys, tested with DC. 200, DC. 550 and DC. 710, in comparison with S.A.E. 20 for 2 hours under 1500 gr load showed aluminium to be worn most and spring steel the least. DC. 710 is an improvement over DC. 200 and excepting aluminium is about the equivalent of the S.A.E. 20 oil.

Three silicone greases and test results are described—one thickened with carbon black is serviceable at −4° F and at 200–300° F has between 5 and 10 times the service life of high temperature petroleum greases, it is suitable for use in ball bearings operating under 150 psi at speed of 1750 rpm and under these conditions was still serviceable after 2500 hours at 257° F; at 347° F it had a service life of 900 hours. Another type thickened with a metallic soap gave good performance at 300° F at a speed of 10,000 r.p.m. The third type is similar to the last and does thicken at −90° F has given good performance in bearings operated at 200° F. These greases lose less than 5% at 175° C in a four hour test, compared with 34–58% loss that high temperature petroleum greases sustain under the same conditions. W. H. C.

**723. Use of Phosphorus Sulphide Organic Reaction Products as "Lube" Oil Additives. Part 3.** G. G. Pritzker. *Nat. Petrol. News. Tech. Sect.*, 5.12.45, **37** (49), R.1001.—The more severe conditions of temperature and pressure met with in modern engines and bearings has led to the development of additives containing both phosphorus and sulphur in order to obtain superior materials for the purpose, these elements being known to impart extreme pressure, film strength and anti-corrosive properties, some also acting as detergents. In this paper U.S. patents since 1938, are surveyed in two sections. Group I covers 80 specifications relating to the reaction of inorganic phosphorus sulphide with various organic materials. Group II relates to 34 specifications of organic compounds containing phosphorus and sulphur as the essential constituents.

The patents disclose a diversity of materials and organic compounds, containing sulphur and phosphorus, or reacted with various phosphorus-sulphur, phosphorus-oxygen or phosphorus-sulphur-bromine compounds. Some recent and interesting specifications are :—

In Group I. Probably the basic patent of the group is that of Chittich's (2,142,998—1939) in which a mineral, animal or vegetable oil is treated with a phosphorus compound such as a halide, oxyhalide, or compounds of the oxygen family including oxides, sulphides, tellurides or selenides; metallic phosphides such as sodium or tin phosphites, at a temperature high enough to cause the phosphorus to react with the oil. The sludge formed is removed and 10% of the reacted product is added to lubricating oil; Cook (2,323,943—1945) by reacting an acylated phenol with $P_2S_5$, produces di-(acylphenyl) thiophosphates of an alkaline earth or of Ni, Al, Pb, Hg, Cd, Zn, Mg, etc., which have heat stability, extreme pressure and good pour point characteristics. He states that the –C=O– group in the product provides sludge dissolving, detergent and oiliness properties. In patent (2,368,000—1945) Cook specifies compounds such as Ba di(ethyl hexyl), or Ba di-tetradecyl, dithiophosphates for use as anti-foaming crankcase lubricants. These are made by reacting $P_2S_5$ at 90–100° C with branched chain alcohols or mixtures of alcohols and ketones.

In Group II. For steam cylinder lubricating Downing (2,215,956—1940) employs a tricresyl or (triphenyl, trinaphthyl, trinitro-phenyl) monothiophosphate and phosphite; Lincoln (2,339,710—1944) obtains high film strength and oiliness agents for lubricating oils by reacting an amine with $PSCl_3$; Morgan (2,301,918—1942) gives a formula for a flushing oil consisting of 88·9% fuel oil, 10% xylol, 0·5% each of sulphurized cresyl phosphate and phosphite. W. H. C.

**724. Mechanical Testing of Extreme Pressure Lubricants (with Special Reference to Hypoid Oils).** H. L. West. *J. Inst. Petrol.*, April 1946, **32** (268), 206–229.—In an attempt to provide a source of information in a readily available and comparable basis, this paper was prepared for the Lubricants Panel of Sub-Committee No. 5 of the Standardization Committee of the Institute of Petroleum. The historical development of E.P. lubricants is given, followed by a study of the Almen, Timken, Four-Ball, Falex and S.A.E. machines. The correlation of the test results of the various machines is reviewed. An appendix gives several standard methods of testing E.P. lubricants. A. H. N.

**725. Lithium Soap Greases.** Anon. *Chem. Trade J.*, 26.4.46, **118** (3075), 546.—This reviews E.P. 575,544 of 1946 granted to Shell Development Co. for an improved lithium soap grease which covers a grease containing an oxidation inhibitor made with a low pour point and low viscosity mineral oil with V.G.C. greater than 0·84.

The patent claims that such greases must contain free fatty acid to prevent excessive gelling, and recommends 0·5% free acidity calculated as stearic acid.

The use of a naphthenic oil base rather than a paraffinic oil improves low temperature properties.

In manufacturing a slurry of the soap in oil is heated to about 375° F and phenyl alpha naphthylamine added. Heating is continued to 385–400° F when the grease is run into open pans and quickly cooled.

By this means a grease containing 7% soap can be produced with A.S.T.M. penetration of 275, with operating range down to −67° F, and with low bleeding tendencies. D. L. S.

**726. Lubrication Vade Mecum Addendum.** (5). E. W. Steinitz. *Petroleum*, May 1946, **9** (5), 107.—Part 5 of the Addendum to the *Lubrication Vade Mecum* includes

notes on the problems concerned in the lubrication of air-liquefying plant, barrel cleaning and washing machines, colour enamel and sand-grinding mills, tableting and pelleting machines and glass-blowing apparatus. Cable ways, capstans, diesel, electric and steam locomotives are also dealt with. G. A. C.

## Special Hydrocarbon Products.

**727. Crystallography of Waxes and Related Substances (2).** L. Ivanovszky and J. H. Wredden. *Petroleum*, May 1946, **9** (5), 110.—The crystallography of thin wax films produced without the use of solvents is discussed. Polarized light was used in the microscopical examination of the films produced under four sets of experimental conditions. Methods used included pressureless cooling, slow cooling under slight pressure, shock cooling under slight pressure and shock cooling under pressure.

Microscopic examination showed that the development of the needel-shaped wax crystals is influenced by rate of cooling and pressure, the formation being almost completely suppressed by shock cooling under pressure. G. A. C.

## Miscellaneous Products.

**728. New Synthetic Rubbers Based on Methylpentadiene.** F. M. McMillan, E. J. Bishop, K. E. Marple and T. W. Evans. *India Rubber World*, Feb. 1946 (Reprint).—The properties of methylpentadiene and polymers and their applications are discussed. Products in which methylpentadiene is the major component and in which the other component is another diolefin have the most value for general application in the synthetic rubber industry. Methylpentadiene is a reactive double saturated hydrocarbon of the same type as butadiene. It can be polymerized at 100° C in an emulsion system employing standard GR-S equipment. The unvulcanized polymer exhibits a rubber-like tackiness, which is not lost during storage, and the plasticity can be controlled by varying the polymerization conditions. The unvulcanized polymer is subject to viscous flow under prolonged stress, and although resistant to oxidation, slow oxidation will occur, thus an anti-oxidant should be added.

Milling and processing characteristics are superior to any of the available synthetics, pigments and plasticisers are easily incorporated. Vulcanization of methylpentadiene polymers is affected with the conventional curing agent used for GR-S and natural rubber. The polymers have the same durometer hardness and tear strength as GR-S but the tensile strength is lower. The product makes a satisfactory tyre rubber and could find use in wire insulation, and as a blending agent to correct some of the differences of other rubbers. G. A. C.

**729. Production of Synthetic Rubber Reached Nearly 700,000 Tons in 1945.** W. W. Burns. *Oil Gas J.*, 30.3.46, **44** (47), 125.—Synthetic rubber consumption in United States rose from 6000 tons in 1941 to 693,392 tons in 1945. Since the Japanese surrender, 3366 tons of natural rubber have been imported from the East Indies, and some 95,800 tons are in store there. Unsettled political conditions in the East Indies will keep exports below estimated 650,000 tons annually, and it would be two or more years before American industry could return to the unlimited use of natural rubber. General purpose synthetic rubber can be sold about 4 cents cheaper than the natural product. G. A. C.

## Engines and Automotive Equipment.

**730. The Gas Turbine Discussion.** Dr. S. G. Hooker, Dr. H. R. Ricardo, R. M. Clarkson and W. G. Carter. *J. Roy. Aero. Soc.*, May 1946, **50** (425), 298.—The main contributors to the discussion covered four fields:—(1) application of the G.T. to aircraft and propulsion; (2) turbine compounding of the piston aero engine; (3) application of G.T. to commercial aviation; and (4) application to military aircraft. The main conclusions were:

(1) Dr. Hooker. (*a*) The G.T. is lighter than the corresponding reciprocating engine; (*b*) A higher proportion of its maximum power is available at cruising conditions than is possible with the piston engine; (*c*) It operates most efficiently at high altitudes

and at high speeds; (*d*) Its maintenance costs are low and safer and cheaper fuels can be used.

(2) Dr. Ricardo outlined a compound engine, comprising a blower, a small piston engine in place of the usual combustion chamber and a turbine. The piston engine delivers and the blower consumes, about the same power while the turbine will deliver 50% more than either. The piston engine operates to advantage at the high temperatures (greater than 1500° C) of the cycle whilst the turbine delivers power at the low temperatures, for which it is better suited. Preliminary experiments with a simple valveless 2-stroke cylinder working with inlet pressure 4·4 atm at 2,800 r.p.m., have shown that between 50 and 60 lb of diesel oil per hour per litre of cylinder capacity can be burned. The maximum cylinder pressure did not exceed 1400 lb/sq. in. and thermal troubles were avoided.

The thermal efficiency of such compound plants should be about 42% when cruising at 15,000 ft at 50% of the take-off power, corresponding to a diesel oil consumption of 0·32 lb/s.h.p. hour.

(3) Mr. Clarkson discussed the economics of operating commercial aircraft with G.T. and piston engines. For a medium twin feeder line aeroplane the turbine plant to carry the same pay load as the piston version is 22% smaller, 18% cheaper, 22% lighter, 16% faster, requires 21% less installed power, is 32% cheaper to run and can perform 16% more work in a year. For long-range Empire air liners direct operating costs of turbine plants are substantially lower than piston types provided the cruising speeds and altitudes are favourable.

(4) Mr. Carter outlined the peculiar requirements of military aircraft at high Mach number. Increased thrust is required for better climbing performance but the thrust must be provided with a minimum frontal area, *e.g.*, centrifugal engines provide 400 lb-thrust per square foot of frontal area but with axial types the figure may be increased to 750 lbs. I. G. B.

**731. Evolution of Energy in Jet and Rocket Propulsion.** P. Bielkowicz. *Aircraft Engngr*, **18** (205), 90.—The author discusses the following factors :—(1) calorific value of fuels and their relation to unit mixture with the oxygenizing factor; (2) fundamental data on the specific heats of combustion products; (3) dissociation of the products; (4) methods of obtaining the highest temperature in the combustion chamber and eventually the highest velocity of ejection. Fuels are compared on the basis of the heat energy per unit weight of exhaust gases. Thus for 100% efficient heat conversion the thrust for hydrogen is 530 lb/lb, while methane, heptane, aviation petrol, octane, eicosane show thrusts around 455 lb/lb. Owing to the difficulties of handling liquid oxygen the properties of other oxygenizing factors are given—$HNO_3$, $H_2O_2$, $C(NO_3)_4$, $N_2O_4$, $O_2$, $O_3$. Properties of solid powdered fuels are listed but the difficulties of obtaining a perfect mixture with oxygen, air or other liquid are stressed. I. G. B.

**732. Design and Performance of Jet Propulsion Gas Turbine.** D. M. Streid. *Petrol. Engr*, Jan. 1946, **17** (4), 190.—The development of a gas-turbine for jet propulsion by the General Electric Co. is outlined. Design was originally to obtain a 3000-lb static thrust. Later on, in 1945, it was decided to produce a 4000-lb thrust at sea level conditions. This was known as the Type 1–40, jet propulsion gas turbine. Its design and drawings then took three months and the first was completed in January 1944 and delivered for testing. Performance test data are given and, because the tilt of the turbine buckets were not considered satisfactory from a safety viewpoint, the speed had been limited to 8700 r.p.m. a new turbine wheel was installed and the tests repeated, the following data, corrected to 14·7 psi and 59° F at compressor inlet :—

| | |
|---|---|
| Speed | 11,550 r.p.m. |
| Thrust | 4200 lb. |
| Fuel | 5070 lb/hr. |
| Exhaust temperature | 1300° F. |
| Jet diameter | 18·2 inches. |

As the exhaust temperature was far higher than desired, the jet was enlarged to 19 inches, in order to reduce the temperature below 1200° F. Further improvements in the 1–40 gas turbine were developed and three were constructed and were used for tests, the fourth was sent to Lockheed at Burbank, California, and after tests was

installed in the XP.80 A. airplane (the " Shooting Star ") and after flying tests at 10,000 ft in June 1944, was found very satisfactory. The further mechanical improvements to this engine are described, no major redesign was found necessary. A cutaway section of the gas turbine and a diagram of its lubricating system are shown. A detailed description of its components and construction is given. Performance is shown in four graphs and is discussed. This information is now disclosed for the first time.

W. H. C.

**733. Water Injection for Aircraft Engines.** M. R. Rowe and G. T. Ladd. *Flight*, 23.5.46, **49** (1952), 517).—In a review of this U.S. article, *Flight* summarizes the results as :—(1) Water provides the greatest degree of cooling at high power output ; (2) Water-methanol mixtures are superior to water–ethanol mixtures ; (3) Water–methanol mixtures provide the greatest increase in detonation-limited horsepower output ; (4) Water–methanol mixtures provide the greatest saving in engine critical altitude ; (5) Pure alcohol additions should not be used for aircraft engines—they will cause a decrease in detonation—limited output when using 100-octane fuel ; (6) Water injection will permit the use of 91 and 87-octane fuels in place of 100-octane for equivalent power output up to take-off horsepower ; (7) Water injection can be used most efficiently at lean fuel–air mixtures.

I. G. B.

**734. Jameson Aero Engine.** Anon. *Flight*, 23.5.46, **49** (1952), 511.—The article gives details of the devlopment of a 100-hp engine with an extremely low specific consumption, developed by Jameson Aero Engines, Ltd. Performance figures obtained on official development tests were :—

At between 96 and 100 hours :—

Fuel—87 O.N.
B.H.P. full throttle, 104–108 at 3000 r.p.m.
B.M.E.P.—138·3 lb/sq in.
Maximum economical cruising 90 b.h.p.
B.M.E.P.—120 lb/sq in.
Consumption—385 lb/b.h.p. hr.

The high thermal efficiency is attributed to the induction theory based on the fact that turbulence is a disadvantage and that progressive stratification in mixture strength is desirable. This is obtained by arranging the induction system so that the ingoing charge consists of alternating rich and weak mixtures, a cylinder head with minimum turbulence and a device which ensures that the rich portion of the inducted charge enters the combustion chamber last.

A reduction in bearing loads occurs as a result of cutting off peak pressures, resulting in a marked effect on engine life, and after 235 hours running all the principal components were in good shape. The power/weight ratio is low for an engine of its power category and it is believed that further reductions could be made.

I. G. B.

**735. Propelling Machinery for Moderate and High-Powered Motor Ships.** Anon. *Motor Ship*, May 1946, **27** (316), 44.—In a short review, this editorial comment holds the diesel engine as the most efficient prime mover of any that is now constructed. Comparing the price of diesel oil with boiler oil used in steamers, the diesel still shows an operating economy over the steamer. The lowest service figure recorded in modern American geared turbine ships is 0·64 lb/s.h.p. hr. This represents a 50% greater fuel consumption than that of a corresponding motor ship.

The gas turbine offers possibilities of fuel consumptions down to 0·42 lb/s.h.p. hr, these being obtained on large experimental units. Even without fuel-saving equipment, offers have been made to produce engines with guaranteed oil consumption of 0·55 lb/s.h.p. hr. The future trend appears to lie in the use of diesels up to about 7000 s.h.p., with the usual employment of gas turbines above that output. Steam turbines would be used under special applications where they show to advantage.

I. G. B.

**735a. 3300 B.H.P. Gas Turbine for Liberty Ship.** Anon. *Motor Ship*, May 1946, **27** (316), 62.—Resulting from the operating experience with the Elliott Lysolm gas turbine, the U.S. Maritime Commission has ordered a 3300 (max. rating) b.h.p. gas

turbine to power a Liberty ship collier. Estimated details of the engine performance are as follows :—

| | |
|---|---|
| Fuel consumption. . . . . | 0·437 lb/s.h.p. hr. |
| Thermal efficiency . . . . . | 29·7% at full load.<br>27·0% at 50% load.<br>16·0% at 10% load. |
| Machinery weight . . . . . | 339 tons. |
| Lubricating oil for turbines and compressor . . . | 200 S.S.U. at 100° F. |
| Lubricating oil for reduction gears . . . . | 400 S.S.U. at 100° F. |

Combustion chamber design follows the Elliott "elbow" type. It permits heat releases of $2{\cdot}5 \times 10^6$ B.Th.U./cu ft/hr with air supplied at 95 lb/sq in and 650° F and the pressure drop is 16 inch water column. Operating characteristics require air–fuel ratios from 600 : 1 in the low-pressure chamber to 120 : 1 in the high-pressure chamber. The desirability of clean combustion is stressed but no details are given of experience with these chambers. Fuel is vaporized and ignited in the ignition cone. Combustion is completed in proceeding along the double vortex produced by the elbow design. The system succeeds in keeping the chamber lining at a temperature not more than 300° F above the outlet gas temperature. The burners are constant-pressure mechanical atomizing units supplying oil under a pressure of 400 lb/sq in. I. G. B.

## MISCELLANEOUS.

**736. Exposing a Fallacy.** C. J. Deegan. *Oil Gas J.*, 2.3.46, **44** (43), 44.—Economic forces compel the oil industry of U.S.A. to operate with a raw material inventory representing 12–14 years' supply. Between 1918 and 1945 over 86% of all the oil ever produced in U.S.A. has been produced and marketed. During this period the highest inventory was 17·7 years' supply, in 1923; over the whole period the average was 13·6 years' supply; at the end of 1945 the figure was 12·3. The oil industry does not show undue alarm over the present position.

Studies of the reserve and price situation show that the adoption of conservation principles did not fix prices, or nullify the natural economic laws of supply, demand and price: it simply checked wild fluctuations. It seems that the proved oil reserves will fluctuate around 13·5 years' supply. Proven reserves are a function of drilling, which in turn is influenced by the price of oil.

It has been found that by restricting production rates the ultimate recovery of oil from a well is increased. The declines are slower than for uncontrolled production; but a continuous drilling programme is necessary to maintain a given rate of production. Thus additional market demands call for more drilling, and, under the new methods as under the old, the natural interplay of supply, demand and price still tends to keep the raw material inventory of proved reserves at about the same average level of 13–14 years' supply. G. D. H.

**737. Two Rigs Assigned to North Spain Exploration.** Anon. *Oil Gas J.*, 2.3.46, **44** (43), 52.—At Saint Marcet, about 100 miles north of the Spanish frontier, some ten wells produced gas and a considerable amount of oil. On a concession near Montpellier, about 200 miles north of the Pyrenees, approximately fifteen producing wells have been completed.

Exploration is to be undertaken in the Pyrenees area of northern Spain.

G. D. H.

**738. United Kingdom Petroleum Import Trade.** Anon. *Petrol. Times*, 16.3.46, **50** (1269), 267–268. **U.K. January Oil Imports Show Trend Away from Dollar Purchases.** Anon. *Ibid.*, 268–269.—Statistics of trade are presented. A. H. N.

**739. United Kingdom Petroleum Imports and Exports.** Anon. *Petrol. Times*, 13.4.46, **50** (1271), 376.—Statistical data for the imports and exports of petroleum into and from the United Kingdom are given for February and for January and February combined, both for 1946 and 1945. A. H. N.

# BOOKS RECEIVED.

**Bibliography on the Petroleum Industry.** E. De Golyer and Harold Vance. College Station, Texas: Agricultural and Mechanical College of Texas, 1944. Pp. 730 + xxxii.

Published as No. 11, Vol. 15, of the Bulletin of the Agricultural and Mechanical College of Texas, this bibliography of some 20,000 references to petroleum has been made possible by combining Dr. De Golyer's personal bibliography of some 12,000 items with that of the College's Petroleum Engineering Department and a complete bibliography on air-gas lift furnished by S. F. Shaw. The references are indexed under 900 subjects, using Prof. L. C. Uren's decimal system, and are arranged under each subject in chronological order. While the bibliography is not claimed to be complete in its entirety, it should prove of value to one who desires to review progress on any subject over a period of time.

**British Standard 1306 : Part I : 1946. Non-Ferrous Pipes and Piping Installations for and in Connection with Land Boilers.** London : British Standards Institution, 1946. Pp. 14. 2*s*. post free.

This specification applies to the general and detail construction of the pipework connecting a land steam boiler to engine, turbine or industrial plant and all auxiliary pipework in connection therewith, together with the individual pipes and pipe fittings forming parts of such installations.

## Technical Missions to Germany.

The following B.I.O.S. (British Intelligence Objectives Sub-Committee), C.I.O.S. (Combined Intelligence Objectives Sub-Committee) and F.I.A.T. (Field Information Agency, Technical) reports on technical investigations of German industry have been received. Those marked * may be borrowed in accordance with the Library Rules.

### B.I.O.S. REPORTS.

13. German Montan-Wax Industry. 17 pp.
69. Continental Gummiwerke A.G., Hanover. 16 pp.
70. Harburger Gummiwaren-Fabrik Phoenix at Hamburg/Harburg 1. 11 pp.
75. The Production of Acetaldehyde, Acetic Acid, Acetic Anhydride and Acetone from Acetylene at the Bunawerke, Schkopau. 24 pp.
82.* Inspection of Hydrogenation and Fischer–Tropsch Plants in Western Germany during September 1945. 28 pp.
118.* Munich Technical High School. (Fuels and Lubricants.) 71 pp.
119.* Deutsche Versuchsanstalt für Luftfahrt (V.D.L.) Institut für Betriebstoff Forschung. 39 pp.
120.* Wirtschaftliche Forschungs G.m.b.H. Hitzaker Depot. 29 pp.
121.* Wirtschaftliche Forschungs G.m.b.H. (WIFO) Heiligenstadt Installation. 9 pp.
122.* Wirtschaftliche Forschungs G.m.b.H. Interrogation of Herr Helmut Plote of the Construction Department. 20 pp.
125. Ernst Beuttler Werke, Dinglingen, near Lahr. 5 pp.
128. Wood Distillation Plant at Brilon-Wald. 7 pp.
131. The Production of Alcohols and Ketones from Olefines at the Treibstoff Werk, Rheinpreussen, Moers, near Duisberg. 12 pp.
134.* I.G. Farbenindustrie Chemische Werke, Hüls, near Marl, Rechlinghausen. 12 pp.
137.* Cyclopolyolefines (Paper by Dr. J. W. Reppe, I. G. Farben. Research Chemist). 27 pp.
145.* Technical High School, Munich. 5 pp.
152. Developments in Protective Clothing in Germany. 27 pp.
176. Scholler Wood Sugar Plant at Holzminden. 15 pp.

185. The Cellulose Plastics Industry in Germany. 56 pp.
197.* Reichsinstut für Erdölforschung Technische Hochschule, Hanover. 7 pp.
199.* "Ten Years of Oxygen-Gasification at Leuna," by Oberingenieur Sabel. 32 pp.
200.* Organization of Deutsche Versuchsanstalt für Luftfahrt (D.V.L.). 4 pp.
203. The Non-Destructive Testing of Materials and X-Ray Protection Methods. 6 pp.
216. (1) Technical High School, Darmstadt; (2) C. F. Boehringer und Söhne, Mannheim-Waldhof; (3) Dr. Freudenberg, Heidelberg University; (4) Dr. Wolman, wood preservation specialist, Bad Kessingen; (5) Imbert Gas Producer Plant, Cologne. 10 pp.
240. Synthetic Tanning Agents and Leather Auxiliary Products of the I.G. Farbenindustrie. 33 pp.
244. I.G. Hoechst and Ludwigshafen. Manufacture of Sulphuric Acid, I.G. Converter Design and Vanadium Catalyst. 13 pp.
247. German Chemical Plant, with Particular Reference to Centrifuges. 17 pp.
273. Symposium of Interrogations and Reports on German Methods of Statistical Reporting. 206 pp.
280. Interrogation of Prof. Alexander von Philippovich. 22 pp.
294. Hydrogen Peroxide Works of Otto Schickert & Co. at Bad Lauterberg and Rhumspringe. 20 pp.
324.* Band Oil Refinery at Porta, near Minden. 7 pp.
325.* Kaiser Wilhelm–Institut für Strömungsforschung Abteilung, Reibungsforschung, Berlin. Interrogation of Dr. Ing. G. Vogelpohl. 14 pp.
326.* Interrogation of A. Bollhorn, E. Grages and Dr. Gross of Deutsche Erdöl A.G. Berlin. 29 pp.
330.* Wirtschaftliche Forschungs G.m.b.H. (WIFO) Eickeloh Installation. Investigation of Installation and Interrogation of Personnel. 11 pp.
331.* Amalia Benzole Refinery, Harpener Bergwerksverein, Bochum. 4 pp.
332.* Chemische Fabrik Weyl A.G., Sandhoferstr 96–106, Mannheim-Waldhof. 8 pp.
333.* Winkler Generators for Manufacture of Water Gas, etc. 37 pp.
334.* Developments of Geophysical Prospecting in Germany during the War. 5 pp.
335.* Metallgesellschaft A.G. and the Lurgi Group of Chemical Engineering Companies. 209 pp.
345. A German Thermometer for Use in the Range 400–1200° C. 9 pp.
349. German General Rubber Goods Industry. 262 pp.
350. The Synthesis of Intermediates for Polyamides on an Acetylene Basis. (Translation of a Report by Dr. W. Reppe, Ludwigshafen.) 16 pp.
351. Preparation of Adipic Acid from Tetrahydrofuran and Carbon Monoxide. 3 pp.
352. Cyclopolyolefines. Miscellaneous Report compiled from interviews with Dr. Reppe, Dr. Schlichting and Dr. Kröper (I.G. Farben., Ludwigshafen). 4 pp.
354. Polyvinyl Pyrrolidones. Translation of a report by Dr. Fikentscher and Dr. Herrle, Ludwigshafen. 29 pp.
357. Propargyl Alcohol Dehydration and Oxidation to Hexadiinediol. 7 pp.
358. Acrylic Esters. Synthesis from Acetylene and Nickel Carbonyl. 11 pp.
360. Notes on Manufacture of Ethylene Oxide by I.G. Farben. 8 pp.
361. Non-Metallic Materials for Aircraft. Visits to Research Establishments in Germany. 50 pp.
370. Manufacture of Acetaldehyde. 11 pp.
373.* I.G. Farbenindustrie A.G. Ludwigshafen (Fuels and Lubricants). 141 pp.
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447.* Interrogation of Dr. Otto Roelen of Ruhrchemie A.G. 63 pp.
430.* Gesellschaft für Teerverwertung m.b.H., Duisberg-Meiderich and Castrop-Rauxel. 55 pp.

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II— 11. Societe Belge L'Azole, Liege. 6 pp.
V— 30. Chemical Industries in Belgium and France During German Occupation. 55 pp.
VI— 22.* The Fischer–Tropsch Process. 28 pp.

XV— 2. French Shale Oil Industry. 59 pp.
XVII— 2. Engelbert Factories—Liege and Aachen Kabelundgummiwerke—Eupen. 67 pp.
XVIII— 5.* Synthetic Lubricating Oil Production in France. 9 pp.
XIX— 4. Hydrogen Peroxide Production Through 2-Ethyl Anthraquinone. 7 pp.
XXII— 1. Chemische Werke Hüls A.G. 7 pp.
XXII— 7. I.G. Farbenindustrie Synthetic Rubber Plant, Ludwigshafen. 52 pp.
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XXII— 18. Production of Hydrazine Hydrate, I.G. Farben. A.G., Leverkusen, Germany. 8 pp.
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XXII— 21. Synthetic Rubber Plant, Chemische Werke, Hüls. 125 pp.
XXII— 22. Synthetic Rubber Plant, Buna Werke-Schkopau A.G. 65 pp.
XXIII— 4. The Leverkusen Works of I.G. Farben. 50 pp.
XXIII— 15.* I.G. Farbenindustrie A.G. Frankfurt/Main. 30 pp.
XXIII— 16.* Oil Targets in Ruhr and Hanover Areas. 23 pp.
XXIII— 18. Production of Concentrated Hydrogen Peroxide Solutions, Bad Lauterberg (Harz). 31 pp.
XXIV— 6. Gas Turbine Development, B.M.W., Junkers, Daimler Benz. 30 pp.
XXIV— 9. Synthetic Lubricating Oil Plant, Rheinpreussen, Homburg. 17 pp.
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XXIV— 19. Anorgana G.m.b.H. Werk, Gendorf. 38 pp.
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XXV— 1.* Kaiser Wilhelm Institut für Kohlenforschung, Mulheim. 17 pp.
XXV— 4.* Wirtschaftliche Forschungs G.m.b.H. Aussenstelle Munchen 1 (WIFO 1) Stockdorf, near Munich. 5 pp.
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XXVI— 2. Synthetic Emulsifying Agents, Wetting Agents, Detergents and Soap Substitutes. I.G. Farben. A.G., Hoescht/Main. 39 pp.
XXVI— 5.* Wirtschaftliche Forschungs G.m.b.H., Strassfurt and Bad Berka. 7 pp.
XXVI— 11. I.G. Farbenindustrie A.G., Hochst am Main. 84 pp.
XXVI— 48.* Dr. F. Raschig G.m.b.H. Chemische Fabrik, Ludwigshafen am Rhein. 6 pp.
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XXVII— 68.* Fischer–Tropsch Unit, Leipzig Gas Works. 6 pp.
XXVII— 69.* The Fischer–Tropsch Plant of Ruhrchemie A.G., Sterkrade-Holten. 97 pp.
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XXVII— 93. Wirtschaftliche Forschungs G.m.b.H. Fuel Blending Station, Heiligenstadt. 8 pp.
XXVIII— 13. Synthetic Rubber Plant, Buna Werke-Schkopau A.G. 42 pp.
XXVIII— 23.* A.G. Sachsische Werke—Espenhain. 10 pp.
XXVIII— 28. Leuna Works near Merserberg. 11 pp.
XXVIII— 35. Production of Fatty Acids from By-Products of the Fischer–Tropsch Process. 2 pp.
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# Oilfield Exploration and Exploitation.

## Geology.

**740. Functions of Bacteria in the Formation and Accumulation of Petroleum.** C. E. ZoBell. *Oil Wkly.*, 18.2.46, **120** (12), 30.—Bacteria are ubiquitous and physiologically versatile. Experiment shows that they could function under natural conditions, and undoubtedly they are instrumental in the modification and diagenesis of sedimentary materials. Hence they may be important in petroleum formation and accumulation.

Bacteria have been found at a depth of about 25 ft in recent sediments, and changes in sulphate and organic matter content and in redox potential suggest that bacteria have been active since the sediment was deposited. It is virtually impossible to ascertain whether bacteria found in ancient sediments are indigenous. However, they have been found in a sulphur–limestone–anhydrite deposit at a depth of 1560 ft under conditions which seem to preclude contamination. They were unlike known species, and functioned best under conditions obtaining in the formation. Moreover they were able to transform anhydrite to sulphur.

Sulphate-reducing bacteria have been found in oil-well brines. Some bacteria in such brines are lipolytic, and seem to be indigenous, or at least capable of developing in the reservoir fluid.

The highest temperature at which the growth of thermophilic bacteria has been observed is 190° F. Halophilic bacteria which will thrive in brines with a salinity of 15–30% are quite common.

Anaerobic bacteria tend to convert certain kinds of organic matter into substances more like petroleum. Sulphate-reducing bacteria which synthesize hydrocarbons from fatty acids have been reported. The product from *n*-capric acid was primarily a mixture of normal paraffins ranging from $C_{15}H_{32}$ to $C_{28}H_{58}$. Other fatty acids gave similar results, and could themselves have been formed by bacterial decomposition of organic matter.

Ethane and propane, as well as methane, can be produced by anaerobic decomposition of organic matter; aromatic hydrocarbons and their derivatives may be produced by bacterial action on proteins. Anaerobic bacteria have been reported from the Black Sea, which bacteria can transform albuminous and fatty matter into natural gas and dark-coloured oil-like products with a bituminous odour. Altogether it seems possible that bacteria can produce petroleum hydrocarbons.

Hydrogen formed in recent sediments may aid in hydrogenating organic matter to petroleum hydrocarbons. Similarly hydrogen sulphide may help in such reduction, and this gas is widely generated in sediments. Hydrogen has been found in mud gases from the sea floor. Methane is thought to be formed principally by the reduction of carbon dioxide by bacterially-activated hydrogen. Sulphates are reduced in a similar fashion.

Under certain conditions bacteria tend to dissolve carbonates, a process which may set free adsorbed oil and at the same time provide storage space for oil accumulation. Some bacteria physically displace oil from the surface of sedimentary particles.

Detergents may also be formed by bacteria and liberate oil from surfaces. Carbon dioxide generated may aid in oil migration.

Hydrocarbon-oxidizing bacteria are widespread in nature, and they seem to be most abundant in marine sediments and in oil-soaked soil. Some hydrocarbons are attacked more easily than others. It may be significant that most oil-well brines and crudes contain something inhibitory to the activity of hydrocarbon-oxidizers, suggesting that oil accumulates only when these are present. Some sulphate-reducers can assimilate certain aliphatic hydrocarbons. They may tend to increase the proportion of light hydrocarbons in oil.

It has been suggested, but not proved, that sulphate-reducers convert paraffins to naphthenic hydrocarbons.

Lipolytic anaerobic bacteria obtain their oxygen from organic compounds. Decarboxylation or deoxygenation of fats would form hydrocarbons. Anaerobic bacteria capable of attacking fats have been found in recent sediments, in oil-well brines, paraffin dirt, and tar sands. G. D. H.

**741. Oil in Alaska.** H. F. Thomas. *Oil Wkly.*, 4.2.46, **120** (10), 39 (*International Section*).—Oil indications were found in the Iniskin Bay area of Alaska before 1859. By 1904 several wells had been drilled in each of three seepage areas: between Cold and Portage Bays; between Chinitna and Iniskin Bays; in the Controller–Katalla Bay. The deepest well was about 1000 ft. By 1917 31 wells had been drilled in the Katalla field. In the late thirties 2 deep tests were drilled. In the Iniskin Bay area a well was drilled to 8875 ft in the Jurassic, without finding commercial production. It lies on the axis of an anticline. In the Cold Bay area a well went to 5000 ft in hard Jurassic shale, without finding oil or gas. Both areas have prolific seeps and well-defined structures, but there are igneous rocks near.

In a recent expedition 3 separate seeps were found in the Umiat Mountain area. This area is being core-drilled for stratigraphic information. Seeps were found also at Ungoon Point, near Humphrey Point and about 40 miles west of Demarcation Point; at Manning Point, about 2 miles south-east of Barter Island; at Fish River, about 25 miles south-west of the mouth of the Colville river; at Dease Inlet, about 7 miles east of Doonakavik Cove, in the Cape Simpson area.

Due to lack of exposures, geological data are lacking, and geophysical work and core drilling will be necessary.

A prolific seep has been reported near Fort Yukon.

Maps show possible productive areas and the sites of seepages. G. D. H.

**742. Russians Exploit Field Regarded as Very Rich.** Anon. *Oil Wkly.*, 4.3.46, **121** (1), 57 (*International Section*).—Over 20 wells have been completed in the new oilfield near Palvantasi in Uzbekistan. G. D. H.

## Geophysics and Geochemical Prospecting.

**743. Is the Seismograph Still Champ?** J. Sloat. *Oil Wkly.*, 4.2.46, **120** (10), 17.—During 1945 oil companies spent about $30,000,000 on seismic work in U.S.A. The seismograph has found more oil than any other prospecting tool. In seismic surveys the quantities measured are a time interval and a distance along the earth's surface. In order to convert this information into underground dip and depth a velocity of wave travel must be assumed. In some cases experience shows that reflections come from known beds which can be mapped over large areas, but drilling shows many competent beds which do not give consistent reflections, and there are many reflections which cannot be associated with known beds.

In some cases reflections come from fault-planes, and an instance has been noted of reflections from a high river bank. Insufficient is known about the behaviour of reflections where there is lateral variation, pinch-outs, etc.

Velocities may change laterally, and so interpretations may be in error on this account when some distance from the spot where the velocity was measured. Velocity variations may be associated with structure and faulting, and these may be superimposed on regional variations. A case is cited where down flank there is a marked velocity increase. In the absence of corrections seismic dips and correlations tend to show too much relief down the regional dip, since in the basins the increase in total

thickness is commonly due to thickening of young material of relatively low velocity, so leading to a lower average velocity down the regional dip.

The velocity in salt is commonly higher than that in the beds in which it occurs, and so caution must be exercised in mapping beds below salt, for the high velocity, if over a limited area, may lead to an inference of a high which does not exist. It is wise to compare structure above and below the salt, for in most cases the former may provide some clue to the latter. Sand lenses in shale, or anhydrite or basalt in low-velocity beds can give similar errors.

In the Rocky Mountain area the thickness of the low-velocity Tertiary over the high-velocity older beds is variable, again providing sources of error with regard to amounts of closure and position of the axis. Again the form of shallow beds is of value in giving a correct interpretation.

The usual assumption made is that velocity increases with depth and travel time, and so deeper structures will be inferred to have greater closure than shallow ones with which they conform; this will be the case even though the actual time interval is the same on the highs as on the lows. Hence some companies use time contour maps only. If the amount of time closure on a deep bed is greater than on a shallow bed the actual closure in the former must be the greater, regardless of velocity considerations.

Seismograph shooting should be in closed traverses following the inferred regional dip and strike. In general the seismograph tends to show dips which are too steep towards the outcrop. It is worth while examining secondary folds near the main features.

An analysis of drilling results and seismic work in the San Joaquin Valley shows that the seismograph has not been successful in locating productive fault-traps (one reason is that the areas where fault production is most likely are not suitable for accurate seismic work); that it is relatively safe to drill an area with over 100 ft. of seismic closure.

It is necessary to shoot areas difficult of access to get a good picture. Studies of seismograms should be made for areas proved by drilling to be faulted. Similar studies are needed for locating stratigraphic traps.

The present seismograph has no directional control feature, and the inertia and electrical characteristics of the instruments preclude the definition of beds less than about 125 ft apart. In some cases shallow reflections are poorly defined; on others deep reflections are absent. Absence of the reflections may be of geological significance; phase and frequency changes may be associated with changes in lithology.

G. D. H.

## Drilling.

**744. Oil-Base Fuilds—Results and Use in Drilling and Completing Wells.** G. V. Kersten. *Oil Gas J.*, 27.4.46, **44** (57), 135. *Paper Presented before A.P.I.*—The use of oil-base arrears to improve the initial ability of a well to produce oil. Inadequate history indicates that the improved position of the well productivity index is maintained. Well completion practices are improved. Swabbing, washing, and scratching are seldom necessary. The effect of use of oil base on drilling operations tends, in general, to increase rig time. Precautions are necessary to prevent fires, water contamination, and unnecessary fluid losses. The effect of oil base on completion problems is noticeable where the programme calls for more than a drilled hole with a liner. Cement work on blank sections and squeeze work on gun perforations are not as easy as with water base. The expenses of completion are usually increased from \$30/ft on shallow holes to possibly \$30/ft on deep holes where necessary secondary shutoffs are made. Improvements in technique and handling should reduce costs in the future. The operator first using oil base is apt to experience excessive costs until his men are properly educated as to technique of handling and saving the oil base.

A. H. N.

**745. Directional Drilling from Man-Made Islands.** G. B. Nicholson. *Oil Wkly.*, 29.4.46, **121** (9), 18.—In developing Bayou des Glaise field, Iberville Parish, Lousiana, Humble Oil and Refining Co. has commenced an extensive programme which includes the construction of islands elevated above high-water level, each designed for directionally drilling 4 to 6 wells. The islands offer the most satisfactory sites yet discovered

for assuring continuous operations above flood-water levels of the Atchafalaya River, and centralization of several wells on each island by means of directional drilling minimizes island construction and dredging of individual canals. Original plans did not include directional wells or islands, but circumstances which arose during the exploration before and after the first well was completed brought changes of technique to cope with the severe and frequent changes of water level peculiar to the Atchafalaya River Basin. Every well now producing oil at Bayou des Glaise was drilled from an island, and the only vertical hole is the discovery well. Other wells now drilling, already completed, and proposed, are scheduled to be drilled directionally from islands, with the surface locations situated close together in answer to the demands of the swampland. Islands are also built for tank batteries, Christmas trees, and other production installations, and are sufficiently elevated to assure immunity from flood-waters. The river conditions of level, the arrangements made, and building of the islands and retaining walls are described. A. H. N.

**746. Method for Determining Minimum Waiting-on-Cement Time.** R. Farris. *Petrol. Tech.* (*A.I.M.M.E.*), Jan., 1946, **9** (1), Tech. Pub. No. 1968, 1–14.—Waiting-on-cement time has generally been of a length dictated by experience and common practice; it has varied from one area to another, and also with the depth of cementation.

Laboratory tests indicated that a minimum cement strength of 8 lb/sq. in. was desirable, and it was shown that the time required for set to this strength could be expressed as a function on consistometer stirring time to 100 " poises," being approximately three times the latter time. The time of maximum temperature development in cement slurries, due to heat of hydration, is also related to the same consistometer time, being about twice that time. It was also shown that the shut-in casing pressure will build up after cement is placed and will register a maximum at about the same time as the slurry down the hole attains its maximum temperature. From these observations the general rule was formulated that minimum waiting-on-cement time after casing cement jobs in any well is equal to the time when the shut-in casing pressure reaches a maximum, as measured from the initial mixing of cement, times a factor of 1·5. Cement plugs drilled in accordance with this rule were found to drill " firm to hard."

It is concluded that many of the present regulations for waiting on cement require a longer time than is absolutely necessary. The use of the minimum time may lead to the saving of $1200 per well. G. D. H.

**747. Unitized, Portable Flooring and Racks Cut Pulling Costs.** G. M. Wilson. *Oil Wkly.*, 25.3.46, **121** (4), 41.—Standard parts for making floors and demountable tubing racks are described and illustrated. A. H. N.

**748. New Drilling Rig Incorporates Late Improvements.** Anon. *Oil Wkly.*, 25.3.46, **121** (4), 34.—A new drilling rig recently placed in operation by Magnolia Petroleum Co. has several interesting features. The rig has insulated crew change rooms, a clothes-washing machine, a mud-checking laboratory, an office with adjoining bunk-room, and covered steel mud tanks. Everything about the rig has been mounted on steel skids and steel structures, and an abundant use has been made of folding steel catwalks. A direct hydraulic weight indicator and a connecting link that provides for rapid shift from drilling to hoisting operations are included in the rig's mechanical features. Photographs illustrate different parts of the rigs. A. H. N.

**749. An Improved Layout for Steam Drilling Rig.** W. J. Davis. *Petrol. Engr.*, March 1946, **17** (6), 104.—In order to conserve time and manpower and to simplify rigging up, one company worked out a scheme for its steam-drilling rig utilizing many novel features. The first three problems attacked were simplification of rig layout, unitization of slush pumps and their manifolding, and unitization of boiler feed-pumps and their manifolding. After being used on seven locations, drilling records show that rigging-up time for this steam rig has been reduced 50% and drilling time a conservative 30%, which has more than returned the original cost of construction. It was also asserted that not so much as a union or nipple was changed in rigging-up each time from the original layout, so simple and flexible was the

entire set-up. This long paper described in some detail the rig layout, the slush-pump unit and manifolding and other accessory units utilized, and the manner of their dispositions. A. H. N.

**750. Shrink-Thread Drill Pipe and Tool Joints.** N. A. Rebarick and C. Swartsfager. *Petrol. Engr.*, March 1946, **17** (6), 86.—The operations of removing old shrink-thread tool joints, by flame cutting, and applying new joints after heating the joint by a specially designed furnace using either natural or bottled gas, are photographically illustrated in detail and briefly described. A. H. N.

**751. Drilling and Production Patents.** S. W. Briggs, W. C. Bauer, W. J. Ewbank, R. C. Porter, assrs to Briggs Clarifier Co. U.S.P. 2,393,965, 5.2.46. Appl. 26.6.42. Dehydration of oil.

J. C. Vroman. U.S.P. 2,394,123, 5.2.46. Appl. 17.1.45. Valve puller for oil wells.

J. R. Wrathall, R. L. Findley, assrs to Westinghouse Electric Corpn. U.S.P. 2,394,131, 5.2.46. Appl. 26.4.43. Dynamometer.

W. H. Curtis, R. R. Curtis, assrs to Curtis Pump Co. U.S.P. 2,394,154, 5.2.46. Appl. 27.5.42. Booster pump.

D. S. Kaufman, assr to Texaco Development Corpn. U.S.P. 2,394,189, 5.2.46. Appl. 6.10.42. Control of paraffin deposition.

V. J. McCarthy, assr to The Salem Tool Co. U.S.P. 2,394,194, 5.2.46. Appl. 14.4.44. Earth drilling machine.

A. Venditty, assr to Thompson Products. U.S.P. 2,394,276, 5.2.46. Appl. 17.3.43. Swivel joint.

K. Werner, vested in the Alien Property Custodian. U.S.P. 2,394,345, 5.2.46. Appl. 5.3.41. High pressure closing device.

E. Lipson. U.S.P. 2,394,703, 12.2.46. Appl. 6.7.42. Soil analysis by radiant energy.

C. R. Edwards. U.S.P. 2,394,759, 12.2.46. Appl. 13.5.40. Method of recovering elements from well bores.

D. A. Murphy, assr to The National Supply Co. U.S.P. 2,394,800, 12.2.46. Appl. 2.6.41. Rotary swivel.

A. Boynton. U.S.P. 2,394,977, 19.2.46. Appl. 17.9.41. Bottom hole regulator and choke.

H. D. Eisler, J. A. Sharpe, assrs by mesne assignments to Stanolind Oil & Gas Co. U.S.P. 2,394,990, 19.2.46. Appl. 30.10.37. Recording system in seismic surveying.

J. B. Hawley, Jr. U.S.P. 2,395,119, 19.2.46. Appl. 10.4.44. Apparatus for blowing oil wells.

C. V. Millikan, assr to Geophysical Research Corpn. U.S.P. 2,395,137, 19.2.46. Appl. 7.11.44. Oil well testing device.

J. Neufeld, assr to Engineering Laboratories. U.S.P. 2,395,289, 19.2.46. Appl. 27.5.43. Method and apparatus for seismic prospecting.

J. T. Hayward. U.S.P. 2,395,407, 26.2.46. Appl. 10.1.42. Mechanism for measuring the movements of drilling tools and pipe.

O. S. Petty. U.S.P. 2,395,427, 26.2.46. Appl. 7.4.41. Seismic surveying.

H. Hoover Jr., assr by mesne assignments to United Geophysical Co. U.S.P. 2,395,481, 26.2.46. Appl. 24.7.39. Seismic exploration system.

H. G. Doll. assr to Schlumberger Well Surveying Corpn. U.S.P. 2,395,617, 26.2.46. Appl. 24.3.42. Method for determining the oil content of subterranean formations.

J. Fletcher, assr to The Babcock & Wilcox Co. U.S.P. 2,395,855, 5.3.46. Appl. 30.7.40. Fluid separator.

D. M. Phillips, assr to Chiksan Tool Co. U.S.P. 2,396,123, 5.3.46. Appl. 16.3.42. Fluid conducting swivel joint.

O. E. Dempsey. U.S.P. 2,396,162, 5.3.46. Appl. 24.8.42. Means for flowing wells.

T. Aston. U.S.P. 2,396,226, 12.3.46. Appl. 5.9.44. Floatable substructural caissons and the like.

D. R. Moore. U.S.P. 2,396,336, 12.3.46. Appl. 7.10.43. Rotary drilling mud separator.

J. T. Hayward and E. H. Cooley, said Cooley assignor to Engineering Laboratories, Inc. U.S.P. 2,396,420, 12.3.46. Appl. 10.4.40. Well survey apparatus.

E. A. Hertzell, R. H. Anderson, assrs to The Robinson Clay Product Co. U.S.P. 2,396,509, 12.3.46. Appl. 12.11.43. Acidproof cements.

J. F. Tholl, assr to American Tool & Machine Co. U.S.P. 2,396,622, 12.3.46. Appl. 1.5.42. Centrifugal separator.

F. Parrott. U.S.P. 2,396,747, 19.3.46. Appl. 21.6.44. Rock drill.

S. C. Brady. U.S.P. 2,396,817, 19.3.46. Appl. 12.9.44. Fluid lift.

J. E. Walstrom, assr to Schlumberger Well Surveying Corpn. U.S.P. 2,396,935, 19.3.46. Appl. 5.11.42. Acoustic logging.

J. A. Zublin. U.S.P. 2,397,070, 19.3.46. Appl. 10.9.44. Well casing for lateral bores.

W. P. Orr. assr to Standard Oil Development Co. U.S.P. 2,397,199, 26.3.46. Appl. 5.10.42. Apparatus for cleaning wells.

G. H. Ennis, assr of one-half to Robert V. Funk. U.S.P. 2,397,254, 26.3.46. Appl. 28.6.35. Method and apparatus for electrically coring in cased boreholes.

G. H. Ennis, assr of one-half to Robert V. Funk. U.S.P. 2,397,255, 26.3.46. Appl. 4.8.36. Method of and apparatus for electrically determining the formation in wells.

H. G. Smith, T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,377, 26.3.46. Appl. 3.8.42. Mineral oil compositions and methods of suppressing foaming in oils.

H. G. Smith, T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,378, 26.3.46. Appl. 11.8.42. Mineral oil compositions and methods of suppressing foaming in oils.

H. G. Smith, T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,379, 26.3.46. Appl. 21.9.42. Mineral oil composition resistant to foaming.

H. G. Smith, T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,380, 26.3.46. Appl. 21.9.42. Mineral oil composition resistant to foaming.

H. G. Smith, T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,381, 26.3.46. Appl. 19.3.43. Mineral oil compositions and methods of suppressing foaming in oils.

G. A. Humason, assr of 10% to L. C. Christian, 11% to T. J. Faver. U.S.P. 2,397,419, 26.3.46. Appl. 20.3.43. Production lift device. R. B. S.

## Production.

**752. Operation and Cost of Engineering Co-operative.** A. M. Crowell. *Oil Wkly.*, 8.4.46, **121** (6), 48.—A group of co-operative and progressive oil and gas operators in Mississippi have proved that the most common complaint of the older oil and gas-producing States—"lack of requisite data prevented the evaluation of petroleum reservoir behaviour"—can be averted simply and inexpensively. At an average cost of $4.75/well/month an engineering co-operative representing 75% of the wells and 68% of the production of oil and gas in Mississippi has brought an understanding, not only between operators, but also between State and operator, that is unique in the history of the petroleum industry. Continuous pool studies reflecting the complete physical aspects of each oil and gas reservoir of Mississippi make possible an evaluation of economic conditions that is always current. Co-operative service has lightened the burden of the technical staffs of its operator-members, with resulting economies. Unlike the first co-operative formed some twenty years ago, the work of the Mississippi committee is confined to a geological statistical and factual-engineering programme. No agreement or understanding expressed or implied,

with respect to the exploratory and development policy to be pursued, exists between members, and no restrictions are placed on competition in oil and gas operations. This State-wide petroleum engineering committee has proved advantages over the individual field engineering committee wherein membership is confined to actual operating interests. Conservation of oil and gas, rapid acceptance and assimilation of good operating practice and systems is being brought about at a cost of only 1/5 cent/barrel of oil and condensate produced, and this cost is deductible from State and federal income tax.

Details of the costing and benefits of the co-operative systems are given.

A. H. N.

**753. Performance of Distillate Reservoirs in Gas Cycling.** W. Hurst and A. F. van Everdingen. *Petrol. Tech.* (*A.I.M.M.E.*), Jan. 1946, Tech. Pub. No. 1969, 1–15.—A distillate-bearing sand complex is often made up of stringers of different permeabilities. Considering each permeable section that can be traced over a structure as a unit in a parallel arrangement of sand layers, and assuming the same potential distribution in each section, there will be flow parallel to the bedding. The recovery efficiency of recycling in such a sand complex is computed on the basis of this assumption. In the first instance linear flow is considered across a rectangle by making the input well a line source and the output well a line sink.

In order to compute the effect on the recovery efficiency of the position of the wells, the area of a field is considered to be made up of rectangles, each rectangle containing one input well in the centre and two producers located symmetrically with respect to the input well. Formulæ are developed to give the pressure and streamlines in steady-state flow. Furthermore, a method is given for rapidly computing the successive positions of the dry gas front.

If the field is irregular in shape, pressure and streamlines can be obtained by a potentiometric electrical model study. By using the concept of "parallel flow" and the results obtained by mathematical analysis or by electrical model studies for a homogeneous formation, the effects of different permeabilities and of the location of the wells can be established. From these studies it is clear that the efficiency of recycling can be profoundly influenced by differences in permeability among the various parallel strata. The similarity between the displacement of wet by dry gas in cycling and the displacement of oil by water in secondary recovery suggests that the "parallel-flow" method of analysis can be used to refine estimates of the over-all recovery efficiency of water-flooding. G. D. H.

**754. Formaldehyde as an Inhibitor of Corrosion by Hydrogen Sulphide.** P. L. Menaul and T. H. Dunn. *Petrol. Tech.* (*A.I.M.M.E.*), Jan. 1946, **9** (1), Tech. Pub. No. 1970, 1–9.—Hydrogen sulphide in the presence of oilfield brine is highly corrosive, and so leads to many troubles. Special alloys and coating equipment have, in the main, been unsatisfactory or too expensive, and alkali treatment generally causes objectionable precipitates.

Tests with a variety of chemicals showed formaldehyde to be the best inhibitor, reducing the corrosion rate to about one-ninth of that in the absence of any inhibitor. Its mode of action is not known, but it appears that it may form a thin highly protective film on the metal.

In wells batch injection of 40% aqueous formaldehyde was used, the general amount used being 1 quart to 100 brl of sulphide water produced. In some cases the formaldehyde effected a notable reduction in corrosion; in others there was decided improvement when stray electric currents were eliminated. After a year's trial examination of equipment showed that the treatment had virtually stopped sulphide corrosion. There was a significant decrease in the number of pulling jobs on the test wells, and a saving in pulling and replacement expenses. G. D. H.

**755. Dry-Hole Knowledge Necessary in Secondary Oil Recovery.** F. R. Cozzens. *Oil Wkly.*, 8.4.46, **121** (6), 47.—The use of the history of dry holes to avoid unnecessary duplication of failure in considering secondary oil recovery is discussed. A. H. N.

**756. Electrification of Smackover Wells Lowers Lifting Costs 36%.** G. Weber. *Oil Gas J.*, 27.4.46, **44** (51), 115.—Smackover wells are in the "heavy water production–

stripper class," with many of them making about 95% water. Pumping costs had been equal to a large proportion of total revenue. Electrified pumping units have yielded substantial savings. Prior to conversion, each well was studied individually and the size and power requirement of each installation were computed according to the empirical formulæ:

$$\text{Peak polished rod load} = (\text{wt. rods} + \text{wt. fluid})\left(1 + \frac{\text{Stroke} \times \overline{SPM^2}}{70{,}400}\right)$$

$$\text{Peak torque} = (\text{Peak polished rod load} - (\text{wt. rods} + \tfrac{1}{2}\ \text{wt. fluid}) \left(\frac{\text{Stroke}}{2}\right)$$

These formulæ have been found adaptable to such installations. Continued study of wells after conversion has aided in improving their production and better equipping additional wells. In some cases, horsepower requirements have been reduced by one-third by changing types of pumps. Common practice with old equipment was to pump at greatest possible speeds, regardless of pounding, to recover maximum production. In new installations constant study by engineers and pumpers has resulted in improved production by adapting length of stroke and pumping speed to conditions causing least pounding, thereby reducing maintenance, repair, down time, and kilowatt hours used/barrel of fluid lifted. A. H. N.

**757. Graphical Prediction of Water-Flooding Intakes.** S. T. Yuster. *Oil Wkly.*, 22.4.46, **121** (8), 36.—A graphical method for predicting the behaviour of a water input well in a water-flood has been developed based upon certain theoretical equations and involving certain assumptions regarding the flow of the involved fluids. The four variables—effective permeability, time, cumulative volume, and water injection rate—when considered in a uniform permeability sand, any two may be computed by use of the nomograph if the other two are fixed. The graphs may be adapted to a sand having a heterogeneous permeability profile with certain restrictions by taking a summation of the behaviour of the different permeability brackets. The nomograph scale may be changed by modifying the variables with appropriate factors. This increases the usefulness and flexibility of the method. Variation in well spacing and shot-well radii cannot be corrected or changed in the graphs contained in this report. New graphs must be drawn if such variations occur. However, the graphs can be corrected for the other variables involved in water-flooding. A. H. N.

**758. General Features of Water-Flood Systems.** Anon. *Oil Wkly.*, 13.5.46, **121** (11), 39–40.—The elements of water-flooding systems are briefly discussed. Particular attention is paid to source and treatment of the water. A. H. N.

**759. Why Well Tests Must be Made Accurately.** K. M. Fagin. *Petrol. Engr.*, March 1946, **17** (6), 75–76.—The reasons for making accurate tests on wells are discussed. Important tests are: (1) Coring tests and core analysis; (2) Drillstem tests; (3) Electric logging; (4) Radioactivity logging; (5) Caliper logging; (6) "Straight-hole" tests; (7) Pressure test of casing; (8) Temperature survey for cementing test; (9) Initial production (potential) test; (10) Initial bottom-hole pressure and temperature test; (11) Periodic gas-oil ratio tests; (12) Periodic potential tests; (13) Periodic water-oil ratio or "shake-out" tests; (14) Periodic bottom-hole pressure tests; (15) Periodic production efficiency or productivity index tests; (16) Bottom-hole fluid sampling tests and analysis; (17) Periodic wellhead pressure tests. The significance of the prevailing conditions at the time of the tests, in their interpretation, is briefly indicated. A. H. N.

**760. Acre-Foot Recoveries From Oilfields. Part 2.** S. F. Shaw. *Petrol. Engr.*, March 1946, **17** (6), 254.—Statistical data on production from a large number of fields in the different States of America are presented and then combined into one comprehensive table. The cumulative recovery is 8629 million brl or 10,320 brl/acre, or 144 brl/acre-foot. Ultimate recovery from 800,215 acres averaging 73·5 ft in thickness, is 10,967 million brl, or 13,700 brl/acre, or 187 brl/acre-foot. The area of 2800 fields in the United States, which includes nearly all fields except those in Kentucky, Nebraska, New York, Ohio, Pennsylvania, West Virginia, and the Pan-

handle of Texas, for which figures on acreage are not available, aggregates 5,262,600 acres from which cumulative production has amounted to 25,157 million brl, or 4770 brls/acre. Ultimate recovery from these fields is estimated at 44,268 million brl or 8400 brl/acre.

In view of the general average of 187 brl/acre-foot shown for fields in all parts of the United States, it is surmised that the much higher figures used for acre-foot recoveries for many of the newer and principal fields of the United States may be optimistic. If such is the case, the answer will be shown in downward revisions of ultimate recovery in these fields as they become depleted. Already some estimates have been revised downward, but it remains to be seen whether this will apply to many of the larger fields where, by reason of circumstances, it was necessary to make estimates by use of the volumetric method. A. H. N.

**761. Oil Well Counterbalancing.** E. N. Kemler. *Oil Wkly.*, 6.5.46, **121** (10), 17–19.—The reasons for using counterbalance—*i.e.*, to reduce the size and power of the prime mover and to lengthen the life of the equipment—are discussed and followed by descriptions and illustrations of several types. To check for correct balance Barrett's method of slipping the clutch may be used. Briefly it is as follows: (1) Set the throttle on the engine at a fixed position; (2) Release the clutch very slowly to the point where it will pull the peak load. Any further release will result in the clutch slipping on some part of the cycle. If the well is properly balanced, the clutch will slip equally on the up and downstroke; (3) On further release of the clutch a well out of balance will slow up and slip on the side which is under-balanced, and speed up on the side which is over-balanced. A little experience in developing a technique will soon show whether the well is noticeably out of balance. A. H. N.

**762. Graphical Mechanics of Counterbalancing Multiple Well Pumping Assemblies.** J. J. Laudermilk. *Oil Wkly.*, 8.4.46, **121** (6), 32.—The principles of balancing a number of wells on the pump by back-crank pumping are explained by solving in detail a problem in which it is assumed that one well will be produced in the normal manner of sucker-rod pumping, whilst two other wells will be produced by back-cranking from the first well. Detailed engineering data are presented and the solution, using a method of graphical balancing of forces, is given in full. A. H. N.

**763. Research and the "Shoe-String" Producer.** F. R. Cozzens. *Petrol. Engr.*, March 1946, **17** (6), 248.—A brief *résumé* of the present trends in research on problems of shoe-string sand production is given, but no references to papers are appended. A. H. N.

**764. Field Effective Permeabilities and Shot-Well Radii.** S. T. Yuster. *Oil Wkly.*, 29.4.46, **121** (9), 24. *Paper Presented at Ninth Technical Conference on Petroleum Production, Pennsylvania State College.*—From certain theoretical deductions an equation has been derived which shows that the logarithm of the cumulative volume of water injected in a water-flood during the radial encroachment period is a linear function of the reciprocal of the injection rate. The slope of the line mentioned will yield the effective permeability of the formation to the flood-waters. The theoretical $y$-intercept of this same line will give the effective shot-well radius. Certain field data have been analysed and a range of relative water permeabilities from about 0·4 to around 0·001 has been found. The variation in relative permeability indicated points towards a possible reaction between the flood-waters and the formation to give a plugging action. The effective shot-well radii also show a wide variation in value. This difference in shot responsiveness indicates a need for further experimentation in well-shooting techniques. A. H. N.

**765. Cable Tools Used to Overhaul Old Wells.** N. A. D'Arcy, Jr. *Petrol. World*, March 1946, **43** (3), 47–48.—It is found economical to use cable tools in cleaning and overhauling old marginal wells to California. One of the problems encountered is the scarcity of experienced cable-tool drillers in the area. A. H. N.

**766. Engineering of Oil Well Abandonments.** W. E. Schoeneck. *Oil Wkly.*, 15.4.46, **121** (7), 44.—The paper deals specifically with oil wells—not with gas well nor condensate wells, which need a separate investigation—and outlines the two major,

interdependent considerations which have to be taken into account in the abandonments of wells: physical and economical considerations. The type of cumulative production curves obtainable with a well are discussed and interpreted. Other characteristics of the wells, gas-oil ratios, water production, etc., are examined. All these are combined with cost studied before the appropriate measures in abandoning the well can be decided on. A. H. N.

**767. Test Flow Chamber.** G. M. Wilson. *Oil Wkly.*, 15.4.46. **121** (7), 43.—One drilling contractor developed a simplified system of conducting drill-stem tests which enables him to observe flow results, but which at the same time practically eliminates possibility of oil escaping to settle over a wide area and cause damage to nearby installations. The 2-inch line coming out of the well-cellar connections was extended out to one side of the location, where it was connected into a small high-pressure separator. A 2-inch gas exhaust line some 200 ft long, and suitably anchored, branches off at that point to exhaust to atmosphere well out of danger of rig installations. Oil then flows on through an increasingly greater size pipe, the last joint of which has perforations for discharging fluid into the sump directly beneath. Some 75 ft down stream from the trap, the 2-inch oil line is enlarged to 6⅝ inch, the latter being a 75-ft length of salvaged casing which is mounted on pipe-leg supports. This pipe reaches well over to within the confines of the walled test sump. At this point the line swages out and is flange connected into a 15-ft length of specially prepared 15-inch casing, the latter spanning the sump and resting on an elevated support made of truncated A-frames made of 2-inch pipe. This piece of large-diameter casing is welded closed at the distant end, and around the lower approximately ¼ of its periphery are cut out numerous large-size perforations, the perforated interval extending the length of the chamber. A. H. N.

**768. Interpretation of Interference Tests in Terms of Permeability. Part 3.** K. B. Barnes. *Oil Gas J.*, 4.5.46, **44** (52), 107.—The fact that in core-permeability measurement an area of 3-inch diameter is taken as representative sample for, say, 20 acres in the field is stressed. In interference tests the whole field, or at least major portions of it, are under test. Interference tests, by definition, must always include at least two wells. The drop in pressure occasioned by producing a well at a certain point is observed at another well or wells which are shut in. The variables contained in such a fluid-flow system include the distances between the shut-in wells and the producing well and the thickness and average permeability of the acreage units represented by each of the closed-in wells. The significance of the various variables and the interpretation of interference tests are discussed. A. H. N.

**769. Wax Saturations in Oil Sands.** J. C. Calhoun and S. T. Yuster. *Oil Wkly.*, 13.5.46, **121** (11), 42.—Sand samples from the Gaines pool of Pennsylvania were extracted, and were found to contain solid paraffin wax. A method was developed to calculate the true oil and wax saturations. By this method the wax saturations were calculated as high as 6%. Considerations indicate that this figure is still too low. It is suggested that this amount of wax would not only hinder the correct determination of oil saturation, but would also affect the production mechanism.

Determination of paraffin point of Gaines crude oil and of the formation temperature show them to be identical within error of determination. This fact indicates the reservoir crude to be wax saturated. Paraffin points on five other Pennsylvania crude oils were determined and compared with the formation temperatures. In two instances—the First and Second Venango sands—there is evidence that the crude oil might be saturated at the formation temperature, in which event solid paraffin might be present. It is suggested that the simplest means by which the presence of wax in these formations could be explained would be by erosion to bring the producing horizon to a depth where the temperature fell below the saturation temperature. It is further suggested that in view of the history of the Gaines pool the wax was present at the time when it was a virgin reservoir. A. H. N.

**770. Trends in Processing Gas Condensate Reservoirs.** F. H. Dotterweich and E. O. Bennett. *Oil Wkly.*, 6.5.46, **121** (10), 25. *Paper Presented before Natural Gasoline Association of America.*—The properties, processing and products of condensate gas are studied. A. H. N.

**771. California Exploration and Production Trends.** N. A. D'Arcy, Jr. *World Petrol.*, March 1946, **17** (3), 48.—A description in general terms of the methods adopted in exploring, drilling, and producing Californian inland and tidal fields is given. Directional wells, water and gravity drive secondary recoveries, and unit operations of fields constitute interesting features. A. H. N.

**772. Field Co-operation Reduced Flare Gas.** G. B. Nicholson. *Oil Wkly.*, 8.4.46, **121** (6), 42.—Production charts recording the pressure of the gas are reproduced, which show peaks and hollows over the 24 hours of the day and also over the week—*e.g.*, shutdowns on week-ends show a "low" region. The paper discusses methods of making production more efficient by eliminating the peaks and hollows in the time charts. A. H. N.

**773. World's Highest-Pressure Well Gauges 8,225 Pounds.** E. H. Short, Jr. *Oil Gas J.*, 4.5.46, **44** (52), 131.—The well head pressure of this gas well is 8,225 lb/sq.in. and, when the weight of the 11,000 ft gas column is added to this value, the bottom hole pressure is approximately 10,500 lb/sq.in. Due to the special care taken, the well was safely brought in and completed. Of special interest is a 15,000 brl/sq.in. working pressure (30,000 lb/sq.in. test pressure) balanced piston valve which can be opened or closed in 10 seconds using only one hand to turn a handle. A. H. N.

**774. Deepest Producing Well.** E. H. Short, Jr. *Oil Gas J.*, 4.5.46, **44** (52), 104.—The well is No. 2 Smith-State Unit 1, owned by Shell Oil Co. It was drilled to 14,301 ft and completed at a plugged-back depth of 13,828 ft, with 7-inch casing set at 13,437 ft. Production of 530 brl/day of 33° A.P.I. gravity through 11/64-inch choke. A. H. N.

## Oilfield Development.

**775. A.I.M.E. Foreign Production Symposium.** Anon. *Oil Wkly.*, 4.3.46, **121** (1), 13.—In 1945 a new field was discovered at Qatif, and extensions were made to the Abqaiq field of Saudi Arabia. Refining facilities there and on Bahrein are being expanded. No. 1 Qatif produces 4000 brl/day of 37·5 gravity oil from 7510 ft in the Arab zone. Wells were being reconditioned at Dammam and on Bahrein. Bahrein produced 7,308,938 brl in 1945, and Dammam 21,124,381 brl.

Most of Iraq's 1945 production of 4,341,000 long tons came from five wells at Kirkuk.

Permits cover 22 million acres of Egypt where geophysical work was resumed in 1945. In 1944 Egypt produced 9,431,000 brl, mainly from Ras Gharib. Several dry wildcats were drilled in 1945.

In 1944 Canada produced 10,166,000 brl of oil, but only 8,560,000 brl in 1945, due to a decline at Turner Valley and to the closing of the Canol pipe-line. In 1945 Norman Wells produced 355,000 brl and Turner Valley 8,055,000 brl. During 1945 the Lloydminster field was extended across the border into Saskatchewan and yielded 15,000 brl. New Brunswick produced 31,000 brl in 1945 and Ontario 113,000 brl. A second well at Jumping Pound was low and obtained salt water. A well in the Brazeau district drilled through a fault into Cretaceous after having been in presumed Mississippi limestone.

Colombia produced 22,866,000 brl on 1945; the De Mares concession gave 15,674,000 brl, the Barco concession 5,540,000 brl, Casabe 1,600,000 brl and Sinu 45,266 brl of oil. At the end of 1945 24 geological parties, and 7 gravity meter and 14 seismograph parties were operating. The Casabe field has been extended eastwards across the Magdalena, and at the south end of the De Mares concession deeper production has been found in an old shallow field.

Peru produced 13,747,346 brl of oil in 1945. Ganso Azul yielded 60,000 brl in 1946. It has 5 wells capable of giving 5000 brl/day each. Ecuador gave 2,670,000 brl of oil in 1945. The entire output came from the Santa Elena Peninsula. A test east of the Andes has had very good oil showings. Brazil produced 79,326 brl in 1945; Lobato yielded 6728 brl, Aratu 6714 brl, Candeias 36,663 brl and Itaparica 29,221 brl.
G. D. H.

**776. A.P.I. Makes Reserves Estimates.** Anon. *Oil Wkly.*, 4.3.46, **121** (1), 11.—During 1945 U.S.A. found 2,110,299,000 brl of new reserves, new pools accounting for 419,984,000 brl. 1,736,717,000 brl of oil was produced in 1945, and at the end of the year reserves were estimated at 20,826,813,000 brl.

During four years of war reserves have increased by 1,237,517,000 brl. Texas has reserves of 11,470,294,000 brl.

Tables list by States the reserves at the beginning and end of 1945, the 1945 production and the amount of oil added by new pools discovered in 1945. Similar data are given for the whole of U.S.A. by years from 1936. G. D. H.

**777. January Drilling Declines.** Anon. *Oil Wkly.*, 4.3.46, **121** (1), 38.—In the five weeks ended 2nd February, 1946, well completions in U.S.A. averaged 472 per week; the December figure was 521, and the January, 1945, figure 419. The January, 1946, completions included 1305 oil wells, 215 gas wells, and 653 dry holes.

A table summarizes the January, 1946, completions by States and districts, and gives comparative data for December and January, 1945. G. D. H.

**778. Norman Wells Oilfield.** J. S. Stewart. *Oil Wkly.*, 4.3.46, **121** (1), 38 (*International Section*).—The Norman Wells field is on the Mackenzie River, 90 miles south of the Arctic Circle. The first well was drilled in 1920, and in 1942 there were four producers supplying a small local refinery. Work on the Canol Project began in May, 1942, and the order to stop drilling was given in March, 1945. 60 productive wells were drilled during the period of contract.

The discovery well encountered a flow of oil at 783 ft, and from 83 ft downwards there had been seepage into the well from the mainly shaly beds. A flow of 10 brl/day was obtained. On deepening to 1025 ft the capacity became 75–125 brl/day. The second well was drilled to 1602 ft, and had a capacity of 175–240 brl/day. On Bear Island a well found showings at 1948 and 2000 ft, but was abandoned in salt water at 2304 ft. A test on the south bank of the river, 4 miles from the discovery well found no oil. 8 miles upstream from the discovery well shallow gas was reported.

Isolated patches of Tertiary rest unconformably on Cretaceous, which in turn lies on Devonian. The latter is commonly bituminous at outcrop. Silurian beds outcrop 5 miles to the northeast and 20 to 25 miles to the southwest of the area. The structures trend generally N.W.–S.E., and are asymmetric, with the steep limbs slightly faulted in some cases. The Normal Wells field is on the southwest flank of a major anticline, the flank dipping at 4–5°. Oil occurs in the Fort Creek (Upper Devonian) reef limestone. The top of the limestone is 1050–1900 ft deep.

The probable productive area outlined exceeds 4000 acres, 1870 acres being under the river.

The saturated section is 0–388 ft thick. The reef pinches out up dip. Saturation is irregular. The latest reserve estimate is 36,250,000 brl. from an area of 2600 acres, 460 acres being under the river and accessible by directional drilling. 10-acre spacing is used on the north bank and 20-acre spacing on Goose and Bear Islands.

Wells are treated with acid and this generally doubles the initial flow. The original reservoir pressure was 695 lb/sq.in. at 1000 ft sub-sea. Solution-gas drive is active on the north bank and Bear Island, but there is evidence of water drive on Goose Island. Up to March, 1945, 1,997,000 brl of oil had been produced.

The bubble-point of the undersaturated crude is 490 lb/sq.in. The oil gravity is 39 to 41·5 and the dissolved gas/oil ratio is 325 cu.ft./brl, while the shrinkage factor is 17·2%.

All wells flow naturally. In February, 1945, the gas/oil ratio was 725, and the average output 4288 brl/day. Reinjection of gas was carried out for five months, the gas injected being equivalent to 602,000 brl of pore space at reservoir pressure.

The pipeline outlet and the refinery at Whitehorse began to operate in April, 1944. The Norman Wells refinery has a capacity of 1200 brl/day.

The Canol agreement, costs, and other points are discussed. G. D. H.

**779. Argentina's Oil Industry During the War Years.** J. E. Thomas. *Oil Wkly.*, 4.2.46, **120** (10), 3 (*International Section*).—Shortage of materials caused the completions in Argentina to fall from 372 in 1941 to 155 in 1945. Production in 1941 was 22,000,000 brl and rose to 24,835,500 brl in 1943, then declined to 22,860,000 brl

in 1945. In recent years the output of the government company has been double that of the private companies.

Production was obtained first in 1907 in the Comodoro Rivadavia field, which gave almost all the country's output until 1925, and even now provides two-thirds. This field has at least fourteen separate producing areas, and lies on the north flank of the San Jorge sedimentary basin. In 1944 an important strike was made on the south flank of the San Jorge basin, near Caleta Olivia, 50 miles south of Comodoro Rivadavia. This strike gave 1000 brl/day from a 10-ft pay at 5381 ft. Good oil showings were found in four sands between 4085 and 4174 ft, and there was a total of ten saturated horizons. Three further oil wells have been completed in this area, which has gentle folds affected by many faults which seem to control production. The oil is from a deeper horizon than that which produces at Comodoro Rivadavia.

Production is obtained also in Mendoza, Salta and Plaza Huincul. Mendoza the newest area, produces about 3,100,000 brl/year, and is believed to have good prospects. Last year a 2500-brl well was completed in the Barrancas field. Challaco of the Plaza Huincul district is a promising field with 63 producers, although only one-third drilled up.

During 1945 Y.P.F. drilled 11 wildcats, 5 in Comodora Rivadavia–Caleta Olivia district, 3 at Plaza Huincul, and one each at Mendoza, Salta and Santa Fe.

Private companies hold 116,260 acres under lease; 247,165,380 acres are reserved for the government, and it is difficult for the private companies to obtain leases on the remainder of the 281,802,842 acres.

Extensive geological and geophysical surveys have been carried out and many prospects await drilling.

A map shows the proven and prospective producing areas, while tables and diagrams give production data and indicate areas prospected geologically and geophysically in 1945. G. D. H.

**780. Exploration in Western Ecuador.** J. E. Thomas. *Oil Wkly.*, 4.2.46, **120** (10), 20 (*International Section*).—Oil production in Ecuador began over 30 years ago, and is still confined to the Santa Elena Peninsula, where seeps were known and production had been obtained by pitting. In 1923 a 45-brl well was completed and the annual production rose to 87,000 brl. In 1926 the output was 350,000 brl. Deeper drilling, usually to 1500–2500 ft, showed other producing areas and zones. In 1928 the output was 1,000,000 brl, in 1937 2,000,000 brl. During 1945 a 300-brl well was completed at 4000 ft in the northern part of the El Tigre field.

The oil is reported to fill fractures in Eocene sands which are not themselves impregnated, and so a Cretaceous source has been suggested. The Sucre sand of the Lower Eocene is over 3000 ft thick, and wells usually penetrate this for 300–400 ft in search of oil.

Several sedimentary basins of restricted size, but with a great thickness of Tertiary, lie along the coast of Ecuador.

Rajada 1, 45 miles west of Guayaquil, was still in Eocene at 11,300 ft. Just to the west Rodeo 1 had reached 9400 ft. Daular 2, 25 miles west of Guayaquil, was abandoned still in the Eocene. 17 tests have been completed by International Ecuadorian Petroleum Co. in the past five years. Faults have been found, and sharp changes in stratigraphy. Several tests have been drilled in the deep basin just east of the basin occupying the tip of the Santa Elena Peninsula. The pools near the tip of the peninsula are said to be in stratigraphic traps, irregular sand lenses, sometimes sealed partly by faults. These traps are difficult to discover.

A map shows the concessions on the Santa Elena Peninsula, and a table gives the production of the different companies annually from 1941, together with the total up to the end of 1940. G. D. H.

**781. Peru's Oil.** J. E. Thomas. *Oil Wkly.*, 4.3.46, **121** (1), 3 (*International Section*).—Oil was produced in Peru as early as 1884, but Peru did not give 1000 brl/day until 1904. The 1945 production is estimated to have been 37,000 brl/day.

Five wells have been completed at Agua Caliente, one being reported to have a potential of 5000 brl/day.

The Zorritos field is Government owned. The Government is exploring the Pirin

area on the shores of Lake Titicaca. It also proposes to drill on the river Ucayali, 125 miles north of Agua Caliente.

In the headwater region of the Amazon formations ranging Devonian to Cretaceous, and possibly the Tertiary, are of interest with regard to oil, but this region presents many difficulties from the point of view of development.

A map shows the concessions, and tables give production data. G. D. H.

**782. Roumanian Crude Production Shows Increase for 1945.** Anon. *Oil Wkly.*, 4.3.46, **121** (1), 57 (*International Section*).—Roumania produced 25,859,400 brl of oil in 1944 and 34,009,696 brl in 1945. G. D. H.

## Transport and Storage.

**783. Transfer Rates Inside Tubes.** W. L. Nelson. *Oil Gas J.*, 4.5.46, **44** (52), 139.—Issue 91 of the Refiners Notebook gives a chart of film transfer rates inside exchanger tubes of $\frac{3}{4}$ to $1\frac{1}{4}$-inch internal diameter, from which the rates for lubricating oils may be determined, given the viscosity and velocity of the oil in the tanks at the estimated film temperature. G. A. C.

**784. Tripling Westward Flow of Iraq Oil.** Anon. *World Petrol.*, April 1946, **17** (4), 40.—The project for a new pipeline from Kirkuk to Tripoli and Haifa is described.

Economic and financial reasons have led Iraq Petroleum to carry out its pre-war projects for increasing oil deliveries to the Levantine coast. The existing 10-inch and 12-inch pipelines are to be increased by installation of welded 16-inch lines to Tripoli and Haifa, giving a total annual capacity of 12,000,000 tons. Pumping capacity is to be increased, and two new submarine pipelines of 5000 ft each are being installed at Haifa, so that six tankers can be loaded simultaneously.

Similar extensions are being made at Tripoli. The pipeline programme may require increased refining facilities at Haifa. Work on the line has already started at Haifa, and the project should be completed in 1948. The new line will follow the same route as the present one. Drilling of new wells in the Kirkuk field is in progress, and the extent of tankage and loading lines required at the terminal sites will depend on the capacity of refineries to be constructed at Tripoli and Haifa. Other auxiliary equipment such as housing, offices, and workshops will also be constructed. G. A. C.

## Refinery Operations.

**785. Selection and Application of Refinery Instruments. Part 3—Liquid Level.** A. Krieg. *Petrol. Engr.*, March 1946, **17** (6), 95.—In considering level-control problems it should be realized that liquid level controllers are, in effect, ratio flow controllers, as they control the out-flow proportional to, or equal to, the inflow over some period of time. The three methods most commonly used for liquid level control may be grouped: (1) Constant level; (2) Averaging level; (3) Interface. These are described as to their operation and scope, and types of instruments for measuring liquid level are classified as: (*a*) Static pressure (Type A); (*b*) Float actuated (Type B); (*c*) Differential pressure (Type C). These are described, and their working and applications are discussed and illustrated under the sections: Type A, Pressure-gauge system; Diaphragm box, Air bubble or purge system. Type B, Ball float; Flexible shaft; Tubular float, null balance, buoyancy or displacement. Type C, Differential; Aneroid differential. Dual level-control instruments are also discussed. W. H. C.

**786. Selection and Application of Refinery Instruments. Part 4—Flow.** A. Krieg. *Petrol. Engr.*, April 1946, **17** (7), 164.—The primary elements used in differential type meters are classified and described and illustrated under: thin plate orifice; flow nozzle; Venturi tube. The Pitot tube, also a primary element, is mainly employed in testing work, and is considered later. A summary is given of their merits and disadvantages covering, cost, flexibility, accuracy, efficiency, and resistance to

wear. Straight vanes are used to nullify turbulence, eddies, etc., and are described and illustrated. Pulsating flow is outlined, and such means as are possible of reducing its effects are discussed. Differential pressure flowmeters are classified under two general types, mechanical and electrical; these are described and discussed with respect to their constructional mechanism, range of pressure differentials, operating procedures, care, and maintenance, and their fundamental mechanisms are shown in sketches under: "U"-type manometers; mechanical lever arm type; low-pressure bell type. Other types include magnetic couplings, which eliminate the use of pressure-type shafts, aneroid bellow type, force balance type (aneroid). Electronic types: area meter (rotameter type); piston type; conductance type. Electrical types: inductance bridge; conductance type. All types being available for indicating or recording purposes. Integrators are discussed, and the use of static pressure pen, and square-root compensation mechanisms are described. Sections covering ratio flow control and volumetric-type meters are included. W. H. C.

**787. Proper Classification of Wastes First Step in Disposal Program. Part 4.** W. B. Hart. *Nat. Petrol. News Tech. Sect.*, 3.4.46, **38** (14), R-292.—Refinery wastes are classified on the basis of their general characteristics and form twelve groups, excluding gases and vapours, which are to be discussed in a later paper. These are: (1) Uncontaminated water waste; (2) storm-water waste; (3) oil and oily wastes, including emulsions; (4) wastes which affect hydrogen-ion concentration, acidity, and alkalinity; (5) wastes which absorb dissolved oxygen; (6) wastes which cause taste and odour; (7) toxic wastes; (8) wastes which are highly concentrated solutions of mineral matter (*i.e.*, carry high dissolved solids); (9) wastes which carry suspended solids and are turbid; (10) coloured wastes; (11) minor miscellaneous wastes; (12) semi-solid and solid wastes. The classification affords important fundamental information for the planning for systematic and efficient disposal of wastes. Each group is widely discussed. The importance of giving due consideration to the effects of flood-waters is stressed. The presence of oil in waste waters, apart from its value, frequently adds greatly to the problems of disposal by the formation of emulsions that are difficult to resolve. W. H. C.

**788. New Type Chromium–Nickel Alloy Offers Wider Range of Refinery Applications.** J. S. Ewing. *Nat. Petrol. News Tech. Sect.*, 3.4.46, **38** (14), R-243.—Information has been released of a new alloy "Stainless-W" developed during the war, which has the corrosion-resistant properties of 18-8, Cr–Ni steel, and in addition can be fabricated and afterwards hardened by heat treatment. Its application to industrial uses has been necessarily limited to special war needs, but its established properties show it to be of particular interest to the petroleum industry. Stainless-W does not contain tungsten, the -W denotes the Wood Works at which the alloy was developed. Its composition is approximately: Carbon 0·5%; Cr 17%; Ni 7%; Ti 0·70%; Al 0·20%; the other elements are present in the normal amounts found in other steels. The alloy is a precipitation hardening steel and, unlike the 18-8 alloy, is magnetic. Certain of the physical properties, which are more directly dependant on metallographic structure than on chemical composition, approach those of ferritic 17 chrome. Examples are: specific gravity coefficient of thermal expansion and electrical resistivity. The difference in electrical resistance and thermal conductivity between the annealed and aged conditions of Stainless-W is believed to be indicative of precipitation. The constant modulus of elasticity of Stainless-W as compared with the decreasing modulus of cold-worked 18-8 is significant. The alloy is treated in two steps: (1) Solution annealing; (2) Ageing (Precipitation hardening). These two steps are fully described and the different temperatures employed are given and structural changes are discussed. An interesting characteristic of the alloy is the extreme uniformity of hardness, in both the unaged and aged conditions, obtainable over the cross sections of bars of various diameters. Mechanical, embrittlement, sea, and atmospheric corrosion, tests show results comparable with 18-8 alloys. Forging, machinability, and spot-welding characteristics are excellent, welded joint strengths, the flux and electrodes used are discussed. Improvements in the design of bubble caps, and the toughness of the alloy allows thinner bubble caps to be employed, with less need for replacements due to wear or breakage, and keeps the weight of equipment down to a minimum. Improved methods are also now in use

for applying this alloy as linings to vessels and overlays to exposed steel surfaces for corrosion protection. W. H. C.

## Refineries and Auxiliary Refinery Plant.

**789. The Resistance to Corrosion by Sea Water of Some α-Tin and α-Tin–Aluminium Bronzes.** J. W. Cuthbertson. *J. Inst. Metals*, 1946, **13**, 317.—A high tin content (not less than 10%) confers excellent resistance on binary bronzes towards impingement attack, such alloys being superior to cupro-nickel and aluminium brass in this respect. The addition of aluminium to bronzes containing 10% tin does not improve their performance significantly, but the presence of the metal is considered to be essential where less tin is incorporated in the alloy. Aeration of the sea water increases the rate of deposit and general attack of all bronzes, but the more resistant of these are nevertheless better able to cope with this form of attack than cupro-nickel, although the latter exhibits a marked superiority in unaerated water. Pre-filming of bronzes improves their resistance towards impingement attack and general corrosion, but does not suppress it completely. It definitely slows up the initial attack, and should be of great value in cases of corrosion arising from temporary solid deposits. Finally, homogeneity of structure and fineness of grain-size both assist towards combating impingement attack. L. B.

**790. Stop Tube Failure in Super-heater by Adding Corrosion Inhibitors.** E. Q. Camp, C. Phillips, and L. Gross. *Nat. Petrol. News Tech. Sect.*, 6.3.46, **38** (10), R-192.—This paper is an abstract of a report entitled "Corrosion of 18-8 Alloy Furnace Tubes in High Temperature Vapour Phase Cracking" published in *Corrosion*, the official organ of the National Association of Corrosion Engineers, September, 1945. In the manufacturing of butadiene, at two refineries, from naphthas (200–400° F) obtained from Refugio crude oil, Texas, the naphtha is vapour cracked, after preheating, by passing through 18-8 type stainless-steel tubes in a superheater at 1300° F. Intense corrosion of the tubes caused their failure after about only 120 hours operating. The plant and its operation are described and the corrosion of the tubes is discussed. A thorough examination of the plant data and analyses of feed and products did not show the cause of corrosion, but further plant and laboratory tests showed that it was not due to the presence of organic acids arising from the presence of dissolved oxygen in the feed, as thought possible, but showed that organic acids inhibited corrosion rather than accelerated it. The analytical data showed that the feed-stock at one refinery contained mercaptan sulphide whereas the other did not. $H_2S$ evolution tests at 1300° F on the combined and fresh feeds of the two refineries showed 1·3 and 8·7 lb and 2·2 and 14·1 lb $H_2S$/1000 brls, respectively. These data do not show the cause of corrosion, but indicated that it may occur because of the absence of certain sulphur compounds—*e.g.*, mercaptans. Laboratory studies of the problem are described; these supported the deductions made from the earlier work, and showed that sulphur (as mercaptan, $CS_2$, free sulphur, etc.) effectively inhibited the type of corrosion experienced. Further plant operations, using feed naphtha to which 0·05–0·5% of sulphur as butyl mercaptan had been added, eliminated excessive corrosion, and confirmed the laboratory results. It was also observed that the presence of water in the feed, within slightly narrower limits, similarly inhibited corrosion, but the reason was not established. As a result of these investigations the plants are now successfully operated by the injection of 0·3% $CS_2$ into the feed naphthas. W. H. C.

**791. Magnesium Gives High Cathodic Protection to Pipelines and Buried Structures.** L. M. Oldt. *Nat. Petrol. News Tech. Sect.*, 6.3.46, **38** (10), R-186.—An outline of cathodic protection is presented and the development of superior magnesium alloy anodes for the purpose by the Dow Chemical Co. is described. The composition of these anodes is given, the copper nickel and iron content being limited to 0·05% Cu, and 0·003% for the Fe and Ni. The current efficiency and life of a magnesium anode depend largely on three factors: the composition of the metal; the electrolyte present; and the current density at which the anode operates. Two types of corrosion of magnesium anodes take place: (1) useful corrosion, which provides the current; and (2) non-useful or local corrosion, representing the current supplied by

the magnesium to provide local cathodes in and on the anode itself; this is a variable which also depends on the three factors mentioned. The second factor affecting the life of an anode is the backfill or the electrolytyte used around the anode. Developments in this direction have shown the gypsum–clay mixtures are more desirable than chlorides, and bentonite has been substituted for the clay. The backfill for high efficiency and life of magnesium anodes are (*a*) for low-resistance soils, bentonite and gypsum in the ratio of 3 : 1; (*b*) for high resistance soils, bentonite, gypsum, anhydrous sodium sulphate in the ratio 2 : 1 : 1. As regards the effect of current density on anode efficiency, it may be said that when using the alloy, a current density of the order of 0·5 milliamperes/sq.in. is sufficient to obtain an efficiency of 50%. Several large cathodic protecting systems using magnesium anodes are described; one of unusual interest is, the protection of a sea-water flume at Freeport, Texas, which consisted of steel piling driven 14 ft into the earth and is 2300 ft long. The flume has polarized, and its life has been extended for an indefinite period by the installing of magnesium anodes. Details are given of the installation of magnesium anodes, covering, spacing, sizes, current output, life, weights, and structures of anodes. W. H. C.

**792. Pipeline Gauging, Sampling, and Testing.** J. A. Sleeth. *Petrol. Engr.*, March 1946, **17** (6), 144.—The steps by which oils are measured, sampled and tested for the determination of volume or amounts shipped or transferred are outlined, particularly in cases where abnormal conditions or results are encountered, and each step is discussed. Methods of gauging temperature measurement and sampling of the oil in vessels, and the A.S.T.M. and A.P.I. sampling devices and methods are outlined. The testing of samples for specific gravity, water, and sediment by distillation and centrifugal methods is discussed, and a comparison of water and sediment contents of various crude oils by these methods is given. Interesting information with respect to the A.P.I. gravity scale is: "When one of the scientific organizations in the early days of the industry undertook to check up on the accuracy of the prevailing hydrometer, it was supposed to conform to the Baumé scale, but it did not. The Baumé scale has a modulus of 140/130 and it was found that the petroleum industry was using an instrument with a modulus of 141·5/131·5. Rather than attempt to call in all the hydrometers in service, a prodigious assignment, the instrument and modulus was adopted as an A.P.I. standard and has continued to be the official standard of the American petroleum industry to the present time." Dry gravity methods are discussed, pressure-bomb, chemical centrifuge, and pressure-filter methods are outlined. Illustrations are shown of banks of water content, distillation equipment, and pressure-bomb assemblies. W. H. C.

## Solvent Refining and Dewaxing.

**793. Modern Refining Processes. 9. Better Technology, Better Lube Oils.** G. Armistead. *Oil Gas J.*, 4.5.46, **44** (52), 115.—A conventional refining operation for the production of lubricants is described and several of the more important classes of additives are outlined. Distillate lubricating-oil cuts taken as overhead and side streams from the vacuum fractionator are treated in a single solvent extraction plant. The residuum from the vacuum distillation is first deasphalted and then dewaxed and finally solvent extracted. In another process the long residuum is passed first through a double solvent extraction process, and is afterwards dewaxed. The treated oil is then vacuum-distilled for separation into the required cuts, which are finally treated with clay.

Additives are incorporated in lubricating oils to improve performance, and include antioxidants, anti-corrosives, extreme pressure assistants, detergents, viscosity index improves, and pour-point depressants. G. A. C.

## Polymerization.

**794. Nomograph for Calculation of Olefin Conversion in Catalytic "Poly" Plant.** E. G. Glass. *Nat. Petrol. News Tech. Sect.*, Jan. 1946, **38** (1), R-33.—A nomograph is presented, and its construction explained, for the rapid assessment of the percentage conversion of olefin into polymer, required during the operating of catalytic

polymerization plants. Samples of the fresh feed and the spent gas are analysed for total olefin contents, and by using the two results in conjunction with the nomograph in the manner described the percentage conversion can be quickly obtained. The nomograph may be constructed on a weight, volume, or mole basis, and gives the desired degree of accuracy. W. H. C.

## Special Processes.

**795. Leaded Gasoline Made Safe for Human Contact.** Anon. *Oil Gas J.*, 4.5.46, **44** (52), 142.—U.S. Pat. 2,390,988 describes a process in which stannic chloride is added to leaded gasoline to remove tetraethyl lead so that the gasoline can be used for cooking fuel, cleaning fluid, or other purposes. An insoluble mixture of diethyl lead chloride and diethyl chloride is produced by the reaction, and removed after agitation with water. G. A. C.

## Patents.

**796. Patents on Refining Processes and Products.** M. D. Peterson, assr to Du Pont de Nemours. U.S.P. 2,391,920, 1.1.46. Process for polymerizing ethylene by heating in the presence of a dialkyl oxide as catalyst.

A. R. Goldsby, assr to Texaco Dev. Corpn. U.S.P. 2,391,962, 1.1.46. A gasoline rich in olefines and aromatics is contacted with an adsorptive clay at 800–100° F and 100 lb to effect olefine isomerization, then contacted with adsorptive clay in the presence of hydrogen at 600–950° F and 100–300 lb to convert the isomerized olefins into isoparaffins, thus improving the lead susceptibility of the gasoline.

C. M. Loane and R. Watson, assr to S. O. C. Indiana. U.S.P. 2,391,988, 1.1.46. A candle comprising a body of wax and a core comprising a mixture of wax and from about 1% to about 30% of an aerogel.

C. J. Randolph, jr., and N. B. Haskell, assr to Texas Co. U.S.P. 2,392,000, 1.1.46. Polymer gasoline mainly saturated and free of aromatics is obtained by passing propylene over a catalyst comprising a calcined mixture of precipitated silica, alumina, and zirconia at 470–495° F.

J. W. Teter, assr to Sinclair Refining Co. U.S.P. 2,392,107, 1.1.46. Direct amination of an olefine is effected by the action of ammonia in the presence of metallic cobalt deposited on a cobalt silicate carrier.

R. L. May, assr to Sinclair Refining Co. U.S.P. 2,392,252–3, 1.1.46. An oxidation inhibitor to add to a lub. oil composition is comprised of the product from the reaction of a monohydroxy aliphatic alcohol with the condensation product of turpentine and phosphorus pentasulphide.

C. E. Welling, assr to Phillips Petroleum Co. U.S.P. 2,392,277, 1.1.46. Levulinic acid and its lower aliphatic alkyl esters are employed to separate close boiling mixtures of aliphatic $C_4$ to $C_6$ hydrocarbons in the gaseous state.

G. E. Liedholm and F. M. McMillan, assr to Shell Dev. Co. U.S.P. 2,392,330, 8.1.46. The 190–200° F fraction of a naphthenic straight-run gasoline is isomerized using $AlCl_3$ as catalyst. It is mixed with the succeeding 200–230° F fraction, and the mixture is dehydrogenated using chromium oxide catalyst. A substantial increase in yield of pure toluol is thus obtained.

F. M. McMillan and G. E. Ludholm, assr to Shell Dev. Co. U.S.P. 2,392,398, 8.1.46. Substantially a development of U.S.P. 2,392,330 (cf. preceding abstract) into a multistage procedure.

D. C. Bond and N. B. Russell, assr to Pure Oil Co. U.S.P. 3,292,454, 8.1.46. Ethylene is contacted with aluminium chloride and its ethylene complexes at 250–350° F in the presence of small amounts of hydrogen chloride. Isobutane and ethyl chloride are obtained.

W. I. Denton and C. H. Schlesman, assr to Socony Vacuum Oil Co. U.S.P. 2,392,466, 8.1.46. Styrene is produced when benzene and ethylene react in the vapour phase with an oxygen containing gas at 600–1100° F under a pressure between 10 and 200 atmospheres.

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J. J. O'Neill, assr to Sinclair Refining Co. U.S.P. 2,392,497, 8.1.46. Fractionation of an aqueous phenol extract of a petroleum oil using a phenol and water in several stages. The product is a resin.

H. G. Berger and D. E. Baderscher, assr to Socony-Vacuum Oil Co. U.S.P. 2,392,570, 8.1.46. An aromatic hydrocarbon fuel is treated with an aliphatic aldehyde and hydrofluoric acid to convert the aromatics into resinous materials. After removal of the latter the fuel has a higher cetane value.

T. T. Noland and E. M. Nygaard, assr to Socony-Vacuum Oil Co. U.S.P. 2,392,610, 8.1.46. Improvement in the ignition quality of a diesel fuel is obtained by the minor addition of a halogen-substituted nitrolic acid or a halogen-substituted pseudonitrole.

J. T. Horeczy and E. F. Wadley, assr to Standard Oil Dev. Co. U.S.P. 2,392,739-2,392,740, 8.1.46. Gaseous olefines can be separated from each other and from gaseous paraffins by treatment with a solution of iodine under controlled conditions.

E. R. Lewis and C. L. Read, assr to Standard Catalytic Co. U.S.P. 2,392,749, 8.1.46. Benzene, toluene, and xylenes are obtained by the solvent extraction of the product from catalytic reforming of a mixture of petroleum fractions containing the corresponding *cyclo*hexanes and the product obtained by destructive hydrogenation of the next succeeding fractions.

J. C. Showalter, assr to Standard Oil Dev. Co. U.S.P. 2,392,779, 8.1.46. A detergent composition in paste form is produced by mixing 20–30% lub. oil or heavy gas oil, 20–35% sodium petroleum sulphonate, 20–35% water, and 20–30% finely divided non-abrasive absorbent material.

M. Friedman, assr to U.S.A. U.S.P. 2,392,846, 15.1.46. Tetraethyl lead is removed from a hydrocarbon fuel by agitation first with anhydrous stannic chloride, then with an adsorbent.

A. Kinsel, assr to L. Sonneborn Sons, Inc. U.S.P. 2,392,853, 15.1.46. A petroleum residual wax containing corrosive substances from $AlCl_3$ treatment is reacted with an alkaline-earth plumbite for their removal.

J. S. Wallace and T. E. Sharp, assrs to S.O.C., Indiana. U.S.P. 2,392,891, 15.1.46. A stable, non-emulsifiable sulphurized oil is obtained from an oil treated with elementary sulphur at 300–360° F by the addition of an oil-soluble alkali sulphonate.

V. Ipatieff and H. Pines, assrs to U.O.P. Co. U.S.P. 2,392,924, 15.1.46. Normal butane is treated with stannic chloride in the presence of hydrogen chloride under such conditions that isobutane is the principal reaction product.

C. W. Watson, assr to The Texas Co. U.S.P. 2,392,960, 15.1.46. The $C_4$ fraction of cracked gas is heated to 650–950° F under pressure to dimerize the butadiene component. It is then heated to 1200–1400° F during contact with a dehydrogenating catalyst to convert the dimer into styrene and dehydrogenate other of the components to butadiene, which is recycled to the dimerization step of the process.

B. S. Grunsfelder, assr to Shell Dev. Co. U.S.P. 2,393,041, 15.1.46. Low-boiling paraffin hydrocarbons are isomerized by reaction with hydrogen in contact with a heavy metal sulphide catalyst at a temperature within the range 400–540° C at a pressure of 10–100 atm.

F. M. McMillan and H. A. Cheney, assrs to Shell Dev. Co. U.S.P. 2,393,051, 15.1.46. In the isomerization of normal pentane at 60° C using $AlCl_3$–$Al_2O_3$ catalyst the yield is maintained by the controlled addition of isobutane.

L. A. Mikeska, assr to Standard Oil Dev. Co. U.S.P. 2,393,181, 15.1.46. A pour-point depressant is obtained when the resinous product from the reaction between an aromatic hydrocarbon and an aliphatic aldehyde (using a Friedel–Crafts catalyst) is acylated.

R. J. Andrews, assr to Wilson Carbon Co., Inc. U.S.P. 2,393,214, 15.1.46. Active carbon is obtained from the acid sludge ex refining of petroleum distillates by a series of heat treatments.

A. C. Byrns, assr to Union Oil Co. U.S.P. 2,393,288, 22.1.46. A suitable catalyst for reforming hydrocarbon mixtures consists of chromites and molybdates of iron cobalt and nickel precipitated on an undried hydrous metal oxide gel.

E. W. M. Fawcett and E. S. Narracott, assrs to Anglo-Iranian Oil Co. U.S.P. 2,393,357, 22.1.46. Normal butane is isomerized by contact with aluminium chlorobromide at a temperature not exceeding 200° C.

F. M. Archibald and H. O. Mottern, assrs to Standard Oil Dev. Co. U.S.P. 2,393,509, 22.1.46. Ethane and chlorine are mixed in suitable proportions, then dispersed in 30% aqueous HCl and subjected to the action of light. Chlorinated products are obtained.

V. Molenari, assr to Bakelite Corpn. U.S.P. 2,393,699, 29.1.46. A petroleum-tar phenol with a side-chain is converted into a lower-boiling phenol by a treatment which includes solution in NaOH, dehydration, and blowing with air.

J. D. Morgan, assr to Cities Service Oil Co. U.S.P. 2,393,797, 29.1.46. A high-temperature grease is obtained by the dispersal of 8–14% lithium soap in a petrolatum.

A. H. Schutte and A. W. Mack. U.S.P. 2,394,015–2,394,016, 5.2.46. Description of a centrifugal method to separate oil and wax from an oil–wax mixture emulsified with water.

A. V. Grosse and W. J. Mattox, assrs to U.O.P. Co. U.S.P. 2,394,170, 5.2.46 $C_6$–$C_{12}$ aliphatic hydrocarbons are dehydrocyclized, then solvent-treated. The extract is also dehydrocyclized in the presence of a catalyst, and the product obtained consists of olefin free aromatics.

N. Levy, assr to I.C.I., Ltd. U.S.P. 2,394,315, 5.2.46. Nitroparaffins are obtained when nitric acid and a low-boiling paraffin, both in the vapour phase, are passed over a catalyst consisting of arsenic or antimony compounds.

O. M. Reiff and J. D. Zech, assrs to Socony–Vacuum Oil Co. U.S.P. 2,394,564, 12.2.46. A synthetic construction material is obtained when the product of the treatment of a chlorinated petroleum wax with a phenol in the presence of $AlCl_3$ is dechlorinated and vulcanized.

L. W. Sproule and J. C. Zimmer, assrs to S. O. Development Co. U.S.P. 2,394,567, 12.2.46. Two formulæ are given for aluminium soap grease.

F. Knoth, Jr., and M. A. Pavlick, assrs to S.O. Development Co. U.S.P. 2,394,616, 12.2.46. A formula is given for a wax-clay emulsion suitable as a liquid coating composition for containers intended for tacky polymers.

M. P. Matuszak, assr to Phillips Petroleum Co. U.S.P. 2,394,625, 12.2.46. Butane is dehydrogenated to butenes in the presence of chromium oxide catalyst. The butenes are dehydrogenated to butadiene as principal product in the presence of chromium oxide catalyst of lower activity.

J. S. Yule, assr to Pure Oil Co. U.S.P. 2,394,735, 12.2.46. A method of preparing a cutting oil is described.

R. C. Archibald, assr to Shell Development Co. U.S.P. 2,394,739, 12.2.46. A pilled dehydrogenating catalyst of the metal sulphide class is reactivated with sulphur dioxide.

I. Bergsteinsson, assr to Shell Development Co. U.S.P. 2,394,743, 12.2.46. Neopentane is the main product obtained when a hydrogenated isobutylene polymer is cracked in the presence of a chromium oxide–alumina catalyst.

C. C. Crawford and W. E. Ross, assrs to Shell Development Co. U.S.P. 2,394,752, 12.2.46. A fluid melt of $AlCl_3$, NaCl, and $ZnCl_2$ is used as an isomerizing catalyst.

S. H. McAllister and N. E. Peery, assrs to Shell Development Co. U.S.P. 2,394,797, 12.2.46. A blending fuel consisting essentially of neohexane and *cyclo*pentane is obtained by two stage isomerization of a suitable cut of a saturated naphthenic gasoline.

H. H. Young and D. Rubenstein, assrs to Industrial Patents Corpn. U.S.P. 2,394,833, 12.2.46. A wax composition suitable for coating cheese consists of a

mixture of paraffin wax with 5–30% of the product of the reaction between alkylolamine and an acylating substance.

E. F. Engelke, assr to Cities Service Oil Co. U.S.P. 2,394,965, 12.2.46. A lube resistant to oxidation and sludging is obtained when it is heated to 340–400° F with 0·5–4% of an inorganic ferric salt, separated from the sludge, neutralized, and clay treated.

R. C. Brandon, assr to S.O. Development Co. U.S.P. 2,394,978, 19.2.46. Alkylated phenols are separated from the soda extract of cracked distillate by preferential precipitation, then subjected to catalytic cracking to produce lower phenols.

R. B. Perkins, jr., assr to Petrolite Corpn. U.S.P. 2,395,011, 19.2.46. Petroleum oils which are solvent-refined by vigorous mixing with a selective solvent have a dielectric constant more than twice that of the oil. The separation of the dispersed oil and solvent phases is effected by the action of an electric field.

J. H. Bishop, assr to Socony–Vacuum Oil Co. U.S.P. 2,395,093, 19.2.46. An alcohol extract of blown lard oil and a condensation product of ethylaniline and formaldehyde are added to a viscous oil to retard rust and emulsion-forming characteristics.

J. C. Hillyer and H. E. Drennan, assrs to Phillips Petroleum Co. U.S.P. 2,395,274, 19.2.46. Aliphatic olefins containing 4–8 carbon atoms are isomerized by passage over bauxite at 500–1300° F.

R. G. Patterson, assr to Phillips Petroleum Co. U.S.P. 2,395,291, 19.2.46. A method is described for the production of porous spongy aluminium chloride catalyst.

J. D. Morgan, assr to Cities Service Oil Co. U.S.P. 2,395,379, 19.2.46. Benzaldehyde is employed as a lubricant between − 68° F. and + 270° F on moving metallic bearing surfaces.

M. R. Arnold, assr to Girdler Corpn. U.S.P. 2,395,529, 26.2.46. A process of purifying a copper ammonium solution used for the absorption of olefins.

H. L. Johnson and J. H. Perrine, assrs to Sun Oil Co. U.S.P. 2,395,627, 26.2.46. A process is described for the preparation of a soluble oil from a naphthenic lub. oil by oxidation with air.

C. B. Barbour, assr to Atlantic Refining Co. U.S.P. 2,395,713, 26.2.46. A method of production of an alkaline-earth metal sulphonate commencing with the sulphonation of a viscous petroleum oil.

A. B. Hersberger, assr to Atlantic Refining Co. U.S.P. 2,395,739, 26.2.46. A resin is obtained by the reaction between an aromatic hydrocarbon and an aldehyde in the presence of a polycarboxylic acid.

E. Amott and W. E. Grebe, assrs to Union Oil Co., U.S.P. 2,395,774, 26.2.46. A method of preparing sulphonic acid metal soaps by treating a lub. oil with sulphuric acid.

K. K. Kearly, assr to S.O. Development Co. U.S.P. 2,395,876, 5.3.46. Olefins are dehydrogenated to diolefins by passage with steam over a catalyst consisting of magnesium oxide, a metal oxide, and small amounts of potassium oxide.

B. H. Lincoln and G. D. Byrket, assrs to Socony–Vacuum Oil Co. U.S.P. 2,395,889, 5.3.46. A lub. oil additive is obtained by reacting sodium trisulphide with a high-mol.-wt. carboxylic acid.

W. A. L. Lande, jr., assr to Porocel Corpn. U.S.P. 2,395,931, 5.3.46. Oils are decolorized by treatment with a water-insoluble metal aluminate.

N. K. Chaney, assr to United Gas Improvement Co. U.S.P. 2,395,954, 5.3.46. A basic substance mixed with a monovalent salt of copper, silver, or mercury is employed to absorb preferentially the olefins and diolefins from a liquid hydrocarbon mixture.

R. V. Shankland, assr to S.O.C. Indiana. U.S.P. 2,395,976, 5.3.46. A tractor fuel is composed of a straight-run heavy naphtha and a synthetic hydrocarbon polymer obtained by hydroforming a petroleum naphtha.

H. B. Kellog and H. C. Reynolds, jr., assrs to S.O. Development Co. U.S.P. 2,396,050, 5.3.46. A substance suitable for addition to a drying-oil composition is obtained from the soda extract of a heavy cracked petroleum fraction.

J. Anderson, E. F. Bullard, and S. H. McAllister, assrs to Shell Development Co. U.S.P. 2,396,144, 5.3.46. A process for the manufacture of cumene from benzene and propylene using sulphuric acid.

J. D. Morgan and R. E. Lowe, assrs to Cities Service Oil Co. U.S.P. 2,396,192, 5.3.46. A formula for a dental instrument lubricant.

E. L. Baldeschweiler and J. C. Zimmer, assrs to S.O. Development Co. U.S.P. 2,396,236, 12.3.46. Corrosion of aluminium fuel tanks is retarded by the addition of an isopropyl ester of an oxidized wax fatty acid to the leaded fuel.

E. A. H. Friedheim. U.S.P. 2,396,258, 12.3.46. New compounds are described which are solid paraffins containing an arsenic radical attached to the carbon chain.

W. J. Sweeney, M. R. Fenske, and G. H. Cummings, assrs to S.O. Development Co. and Röhm and Haas Co. U.S.P. 2,396,299–2,396,303, 12.3.46. Liquid ammonia is used to refine petroleum distillates by solvent extraction.

R. F. Marschner, assr to S.O.C., Indiana. U.S.P. 2,396,331, 12.3.46. A naphthenic gasoline is fractionated, and the appropriate cuts are isomerized using $AlCl_3$ catalyst in a recycle process.

T. H. Rogers and J. S. Wallace, assrs to S.O.C., Indiana. U.S.P. 2,396,345, 12.3.46. A complex glyceride phosphoric acid ester is used to stabilize a sulphurized oil.

G. C. Connolly, assr. to S.O. Development Co. U.S.P. 2,396,641, 19.3.46. A catalytic cracking process in which the catalyst is alumina–tungsten oxide.

M. Blumer, assr to L. Sonneborn Sons, Inc. U.S.P. 2,396,673, 19.3.46. Manufacture of petroleum mahogany sulphonic acids.

D. R. Carmody and H. E. Huber, assrs to S.O.C., Indiana. U.S.P. 2,396,683 19.3.46. Isopropylbenzene is obtained by the action of propylene or benzene in the presence of a phosphoric acid catalyst.

J. M. Musselman and H. P. Lankelma, assrs to S.O.C., Ohio. U.S.P. 2,396,719 19.3.46. A lub. oil addition agent comprising a metal compound of the reaction product of phosphorus pentasulphide and an aliphatic saturated alcohol.

A. J. Morway, assr to S.O. Development Co. U.S.P. 2,396,744, 19.3.46. A grease is made from an aluminium soap obtained by suitable treatment of spent $AlCl_3$ catalyst from the isomerization process.

J. A. Tilton, assr to S.O. Development Co. U.S.P. 2,396,761, 19.3.46. Toluene is obtained from a naphthene-base petroleum by processes involving dehydrogenation, solvent extraction and acid treatment.

E. A. Evans and J. S. Elliott. U.S.P. 2,396,839, 19.3.46. A lub. oil addition agent to increase film rupture strength comprises an oil soluble phosphite ester.

M. S. Taggart, jr., assr to S.O. Development Co. U.S.P. 2,396,900, 19.3.46. Oxygenated organic compounds are obtained by contacting gaseous paraffins with oxygen in the presence of bacteria inoculated plant food.

E. C. Britten, G. H. Coleman, and K. D. G. Clack, assrs to Dow Chemical Co. U.S.P. 2,396,983, 19.3.46. Secondary butyl phenol is used as a solubilizer for petroleum distillate solutions of rotenone.

P. Meyer, assr to Shell Development Co. U.S.P. 2,397,191, 26.3.46. A suitable spreading agent for hydrocarbon oils on water is obtained by treatment of the acid sludge from the refining of cracked distillate.

H. G. Vesterdal, assr to S.O. Development Co. U.S.P. 2,397,301, 26.3.46. Liquid hydrocarbons are obtained from propylene using steam in the presence of chromium oxide–alumina catalyst.

H. G. Smith and T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,377–2,397,381, 26.3.46. Foam-suppressing agents for oils consist of isoamyl octyl phosphates of dimethylanilene, quinoline, pyridene, lutidine, and nicotine.

D. E. Badertscher and R. B. Bishop, assrs to Socony-Vacuum Oil Co. U.S.P. 2,397,398, 26.3.46. A resinous product substantially light in colour and of high melting point is obtained by condensation of formaldehyde and a selected aromatic petroleum fraction. G. R. N.

## PRODUCTS.

### Chemistry and Physics.

**797. Recent Work in the Field of High Pressures.** P. W. Bridgman. *Rev. Mod. Phys.*, 1946, **18**, 1–93.—This exhaustive review summarizes work in the field of high pressures from 1930, the date of publication of Bridgman's book "The Physics of High Pressure," to June 1945, and cites 674 literature references. Critical phenomena involving pressures up to a few hundred atmospheres are not considered, but certain high-pressure phenomena which have up to now only been investigated in this range are included. The high-pressure range now open to study extends to 100,000 atm.

The subject-matter is discussed under the following divisions: technique, mechanical, thermal, optical, chemical, and biological effects of high pressure. Subjects of interest to the petroleum industry which are reviewed include: volumetric studies of single- and two-phase gas and liquid systems containing hydrocarbons, compressibilities of liquid hydrocarbons, effect of high pressures on physical constants and phase changes of, *inter alia*, many hydrocarbons, viscosity changes in hydrocarbons and petroleum oils at high pressures, behaviour of engineering materials, and the effects of high pressures on chemical reactions in liquid and gaseous phases, both catalyzed and uncatalyzed. Reactions listed include the pyrolysis, hydrogenation, oxidation and polymerization of hydrocarbons. The majority of the chemical studies discussed are of direct industrial interest. G. H. B.

**798. A Photoelectric Instrument for Light Scattering Measurements and a Differential Refractometer.** P. P. Debye. *J. Appl. Phys.*, May 1946, **17** (5), 392–398. The method of determining particles sizes and molecular weights by light-scattering measurements on solutions is finding increasing fields of application. In order to obtain the necessary data quickly and conveniently, an instrument has been developed which allows the required light-scattering measurements to be taken on a routine basis. This apparatus is described. It measures transmission and the scattering of light at 90°; two different schemes can be employed to obtain the angular intensity distribution of the scattered light. A description is also given of a compensating refractometer which is used to determine the difference in refractive index of solvent and solution. The instrument, which is simple in design, gives a direct reading of the refractive index difference and has an accuracy of better than $10^{-5}$. The light-scattering instrument has been tested using polystyrene of known molecular weight, and has been applied to study the change of apparent molecular weight (or particle size) of a series of polyvinyl ethers as a function of concentration in some cases, also a number of solvents. For a series of polyvinyl *n*-butyl ether samples which was studied, the relation between the intrinsic viscosity of the benzene solutions and the weight average molecular weight $M$ determined by light scattering is $\eta i = 0{\cdot}365 \times 10^{-7} M^{1{\cdot}45}$. A. H. N.

**799. Thermal and Photochemical Decomposition of Gaseous Aluminium Trimethyl.** L. M. Yeddanapalli and C. C. Schubert. *J. Chem. phys.*, 1946, **14**, 1.—The thermal decomposition of gaseous aluminium trimethyl, in the absence of hydrogen, is nearly 94% homogeneous and of kinetic order 1·5 over the pressure range 10–85 mm measured at room temperature. The reaction products consist largely of methane and to a lesser extent ethane, ethylene, and hydrogen and a solid deposit on the walls of the reaction vessel. A reaction mechanism involving methyl radicals is proposed. The apparent energy of activation, calculated on this basis, is found to be 45 K cal., in agreement with the experimentally determined figure. The high ratio of methane produced to alkyl decomposed suggests that aluminium trimethyl in the vapour state at room temperature must consist at least of tetrameric molecular complexes. In the presence of hydrogen, both the decomposition rate and the energy of activation are reduced as compared to the decomposition of the pure alkyl, a puzzling effect

for which no satisfactory explanation can at present be offered. Photochemically, the presence of hydrogen seems to have little effect on the over-all decomposition, but enhances the relative amount of methane slightly. In this, aluminium trimethyl appears to differ from mercury dimethyl, which is known to decompose faster thermally and photochemically in the presence of hydrogen than in its absence. J. T.

**800. Kinetics of OH Radicals as Determined by their Absorption Spectrum. VI.—Attempt to Trace OH Radicals in the Thermal Hydrogen–Oxygen Reaction.** O. Oldenberg, J. E. Morris, C. T. Morrow, E. G. Schneider, and H. S. Sommers, jr. *J. Chem. phys.*, 1946, **14**, 16.—The steady thermal reaction of hydrogen and oxygen at a pressure of 60 cm and a temperature in the region of 550° C was searched by absorption spectrum technique for free OH radicals. None were detected, although the apparatus would have been sensitive to an OH radical pressure of $4 \times 10^{-4}$ mm. This negative result indicates that near 550° C the rate of reaction which consumed OH is so high that no appreciable accumulation of OH can occur. J. T.

**801. Light Scattering of High Polymer Solutions.** J. Waser, R. M. Badger, and V. Schomaker. *J. Chem. phys.*, 1946, **14**, 43.—A theoretical discussion on determination of molecular-weight distribution of a high polymer, containing no excessively large molecules, from interpretation of its light scattering in solutions at various concentrations. J. T.

**802. Theory of Multimolecular Absorption for a Mixture of Gases.** T. L. Hill. *J. Chem. phys.*, 1946, **14**, 46.—The Brunauer–Emmett–Teller theory of multimolecular absorption is extended to the case of a mixture of two gases. J. T.

## Analysis and Testing.

**803. Applications of the Mass Spectrometer to Refinery Process Control.** W. S. Young. *Nat. Petrol. News Tech. Sect.*, 6.3.46, **38** (10), R-212.—From the experience gained through 8000 analyses determined by the Mass Spectrometer, the Atlantic Refining Co. chemists have provided a sound basis for the information given in this paper on the application of this instrument to refinery process control. Hydrocarbon mixtures for this purpose are placed in two groups: (1) those which can be analysed without preliminary treatment; (2) those which must first be subjected to low-temperature fractionation to remove compounds not determinable by mass spectroscopy or for the purpose of concentrating certain components. The special operating techniques are described and discussed for the analyses of product streams from the fractionating columns of thermal or catalytic cracking, alkylation or polymerization units; together with tables showing mass spectrometer analyses of the product streams, and including the procedures for "difficult" analyses and trouble shooting. Suggestions are given for the operation and maintenance of the spectroscope. Figures are given of the operating times required, in terms of man hours, and eight literature references are recorded. W. H. C.

**804. A Computer for Solving Linear Simultaneous Equations.** C. E. Berry, D. E. Wilcox, S. M. Rock and H. W. Washburn. *J. Appl. Phys.*, April 1946, **17** (4), 262–272.—The mathematical principles of the classical iterative method of solving linear simultaneous equations are discussed. Basic electrical circuits for setting up an analog of the mathematical relations are given, and a commercial model of a 12-equation computer is briefly described. The results of solving a number of problems on the computer are given to illustrate its accuracy and speed of operation. It is found that solving sets of 12 equations requires only $\frac{1}{4}$ to $\frac{1}{7}$ the time required by conventional methods. The computer is to be used in conjunction with mass spectrometers and infra-red spectrophotometry in analysing hydrocarbon mixtures. A. H. N.

**805. The Analysis of Multicomponent Mixtures of Hydrocarbons in the Liquid Phase by Means of Infra-Red Absorption Spectroscopy.** D. L. Fry, R. E. Nusbaum, and H. M. Randall. *J. Appl. Phys.*, March 1946, **17** (3), 150–161.—This is a general method of applying infra-red absorption spectroscopy to the analysis of multicomponent hydro-

carbon mixtures in the liquid phase. The procedure is calibrated by measuring optical densities of synthetic standard samples. A constant thickness cell is used for both standard and unknown samples. Two procedures for converting densities into concentrations are described. Examples are given for four- and five-component mixtures. Data are presented to show the reproducibility of repeated measurements of optical density on the same sample, and results are given to show the agreement between the infra-red analyses and the known composition of synthetic mixtures.

A. H. N.

**806. The Char Value of Kerosine.** F. W. H. Matthews and W. H. Thomas. *J. Inst. Petrol.*, May 1946, **32** (269), 269–288.—A summary is given of the development of the Burning Test for kerosine and describes investigations into the reproducibility of the test when carried out according to I.P. Method 10/44 (T). It is shown that the reproducibility of estimations of char value may not always be of the order claimed by the above method, and that a considerably improved reproducibility may be obtained by the use of wicks extracted successively with water, alcohol, and petroleum ether. Data are given for a variety of kerosines showing the reproducibility of char value determinations by the standard method. The various steps taken in attempts to improve the test are described, and details of experiments carried out in this connection are given. It is shown that, with the exception of the properties of the wicks used, none of the variables connected with the test materially influences the char value. Experiments using extracted wicks have given results which suggest the desirability of modifying the standard test. They are given in detail, the reproducibility data being furnished by two operators using a number of different lamps and chimney glasses and by tests carried out on high, medium, and low char-value kerosines.

A. H. N.

**807. Film-Lubrication between Spherical Surfaces : with an Application to the Theory of the Four-Ball Lubricant Testing Instrument.** J. Howlett. *J. Appl. Phys.*, March 1946, **17** (3), 137–149.—The paper is concerned mainly with the flow of viscous liquid between the outer surfaces of two equal spheres placed in an infinite body of the liquid so that the " minimum separation " of the surfaces (the distance apart at the points of closest approach) is small compared with the radius; one sphere is held at rest, the other rotates at constant speed about an axis which does not pass through the centre of the fixed sphere. The assumption is made that the surfaces are separated by a continuous film of liquid to which the classical theory of hydrodynamical lubrication can be applied—that is, " boundary lubrication," and actual contact between the surfaces are excluded; the partial differential equation (the Reynolds equation) for the pressure distribution in this film is set up, and it is shown that with a suitable choice of boundary conditions a solution can be found in very simple form. From this solution are deduced the total force exerted by the liquid on the moving sphere and the torque, about the axis of rotation, of the forces acting on the fixed sphere. The results are applied to the particular case of the four-ball lubricant testing instrument, in which a sphere is made to rotate about a vertical axis, under axial load, in the central space formed by a set of three equal spheres held stationary so as to touch one another with their centres in a horizontal plane; the whole set of spheres is immersed in the lubricant to be tested. The relations finally obtained express the load on the moving sphere and the torque on the set of fixed spheres in terms of the radius of the spheres, the velocity of rotation, and the viscosity of the liquid; they involve as a parameter the minimum separation of the moving sphere from the fixed spheres, and elimination of this gives the relation between the measurable quantities, load, and torque, which could provide a basis for the use of the instrument as a viscometer. It is found that the torque is a very slowly varying function of the load, being approximately proportional to the logarithm of the load. Further, if it is assumed that the hydrodynamical theory of lubrication is valid only for films whose thickness is greater than some agreed minimum, then the expression for the load on the moving sphere, into which the minimum separation enters, provides a criterion for the range of conditions (of which the load is much the most important) within which the theory does in fact apply to the instrument. Numerical examples are considered, and it is shown that, with allowance for wide departures from the standard size and speed of operation of the instrument, the maximum load which can be sup-

ported by the moving sphere in the hydrodynamical regime cannot be expected to exceed a few hundred grams weight; for loads of greater order the standard continuous-film theory cannot hold, and the forces on the spheres are no longer determined by the viscosity of the liquid. A. H. N.

## Crude Oil.

**808. Emulsification and Demulsification.** (1) A. H. Stuart. *Petroleum*, May 1946, **9** (5), 114.—The principles of emulsification and demulsification are discussed. The stability of an emulsion is a "surface phenomenon" at the interface separating the two phases.

Most solutions form foams, especially long-chain electrolytes. The time noted for a foam to subside is one measure of its stability. Foams are useful in fire-fighting and in flotation methods of mineral separation. Very dilute oil-in-water emulsions, such as are found in the condensed steam from some engines and originating from the lubricant cannot readily be demulsified by chemical means. Emulsions of higher concentrations are stable because of the presence of a third substance which will form a film over the surface of the droplets of the internal phase decreasing the interfacial tension, and thus increasing the film adhesion. Emulsification is almost impossible if the pH value of the water is below 4·5. Colloids differ from emulsions in particle size, which is 1 mμ to 100 mμ for colloids and 100 mμ to 1 mm for emulsions.

Colloids are divided in two classes—suspensoids, in which the dispersed phase is solid, and emulsions, in which it is liquid.

Certain substances, such as gelatine, are stabilizers, being readily adsorbed on to a surface and diffusing very slowly through a fluid, thus resisting change of form.

Size of droplets is not influenced by the nature of emulsifying agent or stabilizer.

Inversion of emulsions occurs; sometimes the one liquid forms the internal phase and sometimes the other. There are three methods of determining which type of emulsion exists; one consists of adding a water-soluble dye, oil-in-water emulsions are readily stained. The oriented wedge theory does not fully explain why a soap of a monovalent base, used as an emulsifying agent, produces an oil-in-water type, whilst one of a divalent metal produces an emulsion of water-in-oil. G.-A. C.

## Gas.

**809. Chemical Utilization of Natural Gas Limited only by Commercial Demand.** A. L. Foster. *Oil Gas J.*, 4.5.46, **44** (52), 83.—The field for conversion of natural gas to profitable products can be divided into two parts. The first is the combination of light hydrocarbons in those of higher molecular weight as liquid fuels such as motor and aviation, diesel, and tractor fuels, which involves simple molecular rearrangements. The second part involves the partial decomposition of light hydrocarbons and their recombination to form products different from the original hydrocarbons.

Alkylation is the most common reaction used, in which an iso-paraffin is reacted with an olefin to form a molecule equal in weight to the total molecular weight of the reactants.

Isomerization is the conversion of straight-chain molecules to isomeric forms; one use is to improve the octane rating of hydrocarbons. By-products of cracking operations form the material for polymerization processes. The Fischer–Tropsch reaction is used to synthesize heavier hydrocarbons from natural gas; catalysts and conditions influencing range of products.

Tables show the raw materials required, and yields of main product in this process, and also the production of synthetic organic chemicals in the United States, from coal-tar as well as other sources; while the production of chemicals is limited to the marked demand, there is a vast quantity of hydrocarbon raw material available in refining and natural gases. G. A. C.

## Engine Fuels.

**810. Resistance to Gum Formation in Motor Fuel in Storage is Studied for the Army.** J. R. Sabina. *Nat. Petrol. News Tech. Sect.*, 6.3.46, **38** (10), R-163.—The results of

special tests made by the gasoline additives group of the C.R.C. for the control of gum formation are reported. The first series were carried out on 41 selected gasolines stored in lacquered and bare iron rust-inhibited "blitz" cans and in drums, and tests were made after 3 and 6 months storage at temperatures which reached a maximum of 110° F. A second series were made in 1944 on 24 samples of 2-103 B, type gasolines extending over 12 to 18 months. The results obtained from the two series of tests led to the following conclusions: (1) A minimum induction period of 480 minutes by the A.S.T.M. method; (2) A maximum of 4 mg A.S.T.M. gum in new gasolines for stabilization of 2-103 b gasoline; (3) Gasoline antioxidant concentration 5–35 lb active ingredient per 1000 brl of gasoline. The lower limit was found necessary to prevent TEL precipitation from certain types of fuels, the maximum limit was suggested to prevent unnecessarily high concentrations in the gasolines; (4) Antioxidants should be limited to those commercial products on which considerable background was already available; (5) Copper-sweetened components should contain from 1 to 3 lb of metal deactivator per 1000 brl as a precautionary measure, in addition to the antioxidant. An extension of the tests were made in 1945 in two series, on the following gasolines: Army 2-114, as received and after addition of a concentrate, consisting of antioxidant and metal deactivator, and Army 2-116, gasoline (unleaded and undyed)—a breaking-in gasoline for engines—which were stored in vehicle tanks for six months, the second series being with gasolines whose gum contents ranged from 1·5 to 50 mg and varying types of antioxidant and concentrations, stored in various vehicle tanks. The effects of operating the vehicle on high-gum-content gasolines being observed by stripping the engines are described. The conclusions drawn from these tests are summarized as follows: (1) Aged gasoline containing less than 7 mg A.S.T.M. gum is satisfactory for continuous use in all Ordnance vehicles; (2) Gasoline containing between 7 and 50 mg gum may be used for short periods, but not continuously for longer than 5000 miles. Track-laying vehicles should not exceed 150 hours operation. Vehicles equipped with vacuum-operated hydramatic transmissions should not be run on gasolines containing more than 7 mg gum; (3) From the standpoint only of precipitation of antioxidants in the induction system of engines, the trialkyl phenols and *para*-phenylenediamine-type compounds were satisfactory at the maximum concentration (35 lb/1000 brl). The aminophenol materials when used at maximum concentration in gasolines of low antioxidant solubility will probably result in sufficient induction system deposits to give rise to faulty engine operation after prolonged use. Information obtained from tests on small stationary engines is included. In general, it is stated the results agree with those of vehicle tests—that is, all gasoline containing more than 1·5 mg caused sufficient engine deposits to reduce significantly the operating time between overhauls. The effect of gum was to cause heavy deposits in the intake manifolds and ports, on intake valve stems and guides, and on intake valve tulips. W. H. C.

## Lubricants.

**811. Dimethyl-Silicone-Polymer Fluids and Their Performance Characteristics in Hydraulic Systems.** V. G. Fitzsimmons, D. L. Pickett, R. O. Militz and W. A. Zisman. *Trans. Amer. Soc. Mech. Engr.*, 10.5.46, **68** (4), 361.—A description of laboratory hydraulic tests on dimethyl silicone polymer fluid in systems operated with small high-pressure pumps, both gear and piston type, is given.

The Pesco pump used has nitrided gears running in high-lead bronze bushings which are pressure loaded against the side of the gears. Thus any wear occurring is found on the face of the gears and on the sliding surfaces of the thrust faces of the bushes and the sides of the gears. The Vickers pump is a 7-piston constant delivery unit enabling almost every type of wear to be observed as hardened steel knuckles pivot on pins of the same material, the pistons slide in the bronze cylinder block, which also slides on the steel-valve plate, and thrust, radial, and combination loaded ball bearings are used. The hydraulic system, containing a filter and means for controlling temperature and pressure of the fluid, was completely dismantled and thoroughly cleaned with suitable solvents before each run. A new filter core was used for each test, and new gears and bushes for each gear pump test run. Tests were made for comparison on reference petroleum hydraulic fluids having viscosities similar to that of the dimethyl silicone polymer fluid at the operating temperature.

Wear, determined by loss in weight, on the Pesco pump parts was less on the silicone fluid than on the petroleum fluid, owing, it was thought, to the formation of protective resins on the bronze bushes. Some gel was collected on the filter element after a run of 500 hr, but no significant change in viscosity occurred. With cast iron in place of the usual bronze bushings, the fluid, run at 600 p.s.i., blackened rapidly with finely dispersed iron particles, the volumetric efficiency of the pump fell by 33⅓% in 5 min, and considerable gel had formed in the fluid. A pump fitted with the same type of cast-iron bushes behaved normally on the petroleum hydraulic fluid at 800 p.s.i. These tests led to the use of a manually operated "slider-and-plate" method for rough sorting of pairs of metals.

Tests on the Vickers pump with the silicone fluid led to breakdowns through the very rapid wear of the hardened steel pins and knuckles, and in both cases the fluid was darkened with dispersed steel particles before pump failure occurred. A pump fitted with bronze knuckles on hardened steel pins ran satisfactorily with no undue wear, the fluid remaining quite clear with no appreciable change in viscosity and formation of gel only round the universal link bearings.

It is concluded that the application of the silicone fluid to many systems now in use is very limited owing to its poor load-carrying capacity where both sliding surfaces are ferrous; that difficulties encountered due to creeping and leakage of the fluid can be overcome; that its excellent behaviour in pumps with the proper metal working parts is promising for its use as a hydraulic and lubricating fluid, and that the low wear rates found in the Pesco pump gears and the absence of wear in the Vickers pump ball-bearing races are considered highly significant, both being examples of steel rolling on steel. J. M. F.

**812. Dimethyl-Silicone-Polymer Fluids and Their Performance Characteristics in Unilaterally Loaded Journal Bearings.** J. E. Brophy, R. O. Militz and W. A. Zisman. *Trans. Amer. Soc. Mech. Engr.*, 10.5.46, **68** (4), 355.—A description of experiments made and the results obtained on a special bearing test machine using dimethyl silicone polymer fluids as lubricant with test bearings of various metals is given.

Dimethyl silicone polymer fluids were the most thoroughly studied, as they have the smallest temperature coefficient of viscosity of any known pure liquid in the lubricant viscosity range, and as they are especially stable to oxidative decomposition.

A machine was designed to enable a fixed circular bearing to be loaded against a rotating journal with force-feed lubrication to all the parts of 26 p.s.i. A special technique was used to ensure a true cylindrical bore, of 0·687 inch diameter, in the ¼-inch-long bearings, provided with a single lubrication hole opposite the loaded area, and the fit on the journal was held to 0·0010 ± 0·0001 inch. The journals were of chromium-plated high-carbon steel except in one test, for which a copper-plated steel was used with a test bearing of cold rolled steel. Other runs were made with test bearings of copper–lead, bronze, tin-base babbitt, cast iron, brass, aluminium (17S), copper, and Alfin metal. A thermocouple, held in the bearing carrier, measured the temperature at the outer surface of the test bearing; no attempt was made to control this or the ambient temperature.

Several procedures were adopted for breaking-in the test bearings, a slow, a fast, and a very fast break-in; each commenced at a load of 500 p.s.i., but the rate of applying the load increment and the value of the increments were varied, the journal speed being held at 1725 r.p.m. throughout.

In the early tests it was found that the slowly broken-in non-ferrous bearings developed high load-carrying capacities and retained them when used with new silicone fluid. Investigation showed that after the slow break-in run the bearings had become lacquered, on the loaded area, with a film approximately 0·0001 inch thick and varying in colour from water-white to a pale yellow. These lacquers were produced in the laboratory, by heating the bearings in the silicone-oil in the open air for longish periods at temperatures of at least 300° F, the time required for steel being longer than for non-ferrous metals. Bearings of some metals so lacquered could be loaded up rapidly to the maximum capacity (6000 p.s.i.) of the machine. Lacquer-treated cast-iron bearings on a chromium-plated steel journal were loaded rapidly to 2000 p.s.i. before seizure occurred, whereas in earlier tests untreated cast-iron bearings on a steel shaft seized at the low load of 250 p.s.i. during a slow break-in run.

Tests made with a petroleum oil, a non-additive aviation engine lubricant of high V.I., using untreated and silicone-oil lacquered bearings, showed the latter to be superior in break-in time and in load-carrying capacity before seizure occurred.

It is concluded that a number of common bearing metals are very promising for use in unilaterally loaded journal bearings lubricated with silicone fluid; that for maximum load-carrying capacity the bearings should be silicone-lacquered, either chemically or by a slow break-in run; that bearing systems of steel on steel or cast-iron are not satisfactory for operation with silicone fluids. J. M. F.

**813. Oxidation of Lubricating Oils.** H. H. Zuidema. *Chem. Rev.*, 1946, **38**, 197–226.—The nature of the oxidation products of pure hydrocarbons, mixtures, and petroleum fractions in the luboil range is considered, with special reference to the results of Chavanne *et al* on *n*-paraffins and napthenes, of Stevens and Roduta on alkylbenzenes and arylmethanes, and of Larsen *et al* on five classes of hydrocarbons. The detailed analytical results and oxygen balances determined by these and other workers are shown to support the general conclusion that the primary oxidation product is a hydroperoxide, the structure of which for various hydrocarbon types is indicated. It is shown that the hydroperoxide subsequently decomposes, usually to a ketone and water, and then to aldehydes, acids, alcohols, etc., with fission of carbon–carbon bonds and the formation of low-molecular products. The intermediate reaction products may also enter into esterification and condensation reactions, the latter being particularly prevalent in the case of aromatics. The application of these general views to the interpretation of oxidation studies on petroleum products is demonstrated on data taken from the literature for a wide variety of luboil and wax products.

The effect of hydrocarbon type on rate of oxidation and the form of oxygen absorption curves is discussed with particular reference to studies by Larsen *et al* on 39 hydrocarbons of 5 different types. Paraffins and alkylnaphthenes oxidize most slowly, the rate being increased by the introduction of olefinic unsaturation or a partly hydrogenated aromatic ring, or the addition of a benzene ring to the end of a long paraffin molecule. The presence of a naphthalene nucleus has the opposite effect, the molecule being stabilized, probably because of the formation of naphthols which inhibit further oxidation.

In a complex hydrocarbon mixture such as a luboil, interaction effects cause the oxidation rate to differ widely from the mean of the rates of the individual components. Furthermore, a component with high stability towards oxidation when tested alone may be preferentially oxidized when in admixture with several other components. Evidence for the view that luboils exhibit an optimum aromaticity with respect to oxidation stability and the effect of added aromatics is presented, and the rôle of natural sulphur compounds considered.

The relative catalytic effect of various metals on the oxidation of hydrocarbons and luboils is reviewed and the nature and effect of typical anti-oxidants briefly indicated. Forty-five literature references are cited. G. H. B.

**814. Secrets of German Lubricating Oil Technology Revealed.** C. I. Kelly. *Petrol. Times*, 11.5.46, **50** (1273), 478.—In concluding the section on manufacturing processes leading to synthetic lubricating oils described in CIOS and BIOS reports, the reviewer deals in the first place with the $AlCl_3$ processes used in France during the German occupation; secondly, with the TTH process wherewith the Germans derived lubricating oils from brown coal tars; thirdly, with incompleted work by the Germans on tetrahydrofuran polymers and on propylene polymers; and, finally, with both a water-soluble torpedo lubricant and a castor oil substitute which as such were utilized by the Germans. A. H. N.

## Bitumen, Asphalt and Tar.

**815. New Developments in Use of Asphalt in Erosion Control.** Anon. *Rds. and Streets*, April 1946, **89** (4), 90.—The use of asphalt in two methods for the control of erosion on highway embankments and slopes is described.

The first methods employs an asphalt concrete mat for protection of roads against wave or current action where the road borders a lake or river; and the second involves

use of a thin film of asphalt for protecting the roadside soil against erosion and to stimulate plant growth.

To protect the embankment slopes an anchored compact mat from 2 to 6 inches in depth, according to circumstances, is placed thereon after the slope has been trued.

A wire mesh may be incorporated, or the mat may be moulded to a thickness of 3 inches on a floating dredge, and conveyed on to the bank above and below water line. An asphalt mat may last several years and completely prevent deterioration by severe wave action.

In the second method 0·2 gal per sq. yd. of slow-curing asphaltic oils of an SC–1 grade heated to about 155° F, is applied to a sandy soil to prevent wind erosion.

To stimulate plant growth and protect against erosion from wind and rain, an MC cutback consisting of asphalt cement fluxed with kerosine is sprayed on to the slope previously seeded with plants native to the area. The hard, brittle asphalt cracks and grass seeds grow up through the cracks. G. A. C.

## Special Hydrocarbon Products.

**816. Improved Petroleum Naphthas and Solvents are Finding Many New Industrial Uses.** B. H. Weil. *Nat. Petrol. News Tech. Sect.*, Jan. 1946, **38** (1), R-65–69.—This survey of naphthas and solvents covers a wide range of petroleum fractions, which, though generally less well known than the usual petroleum products, are of such industrial importance that to attain their conformance to exacting specifications special techniques are employed in their production. The types most generally used are classified as: (1) Straight-run petroleum naphthas; (2) Highly aromatic petroleum naphthas; and (3) Technically pure hydrocarbons from petroleum. The general properties and uses and the technique by which they are made are described; and the important tests to which they must conform are given. Class 1 includes an endless number of close-cut fractions of naphthas for rubber solvent, benzene diluents or textile spirits, lacquer diluents and varnish makers and paint naphtha, mineral spirits and Stoddart solvents. Class 2 includes fractions controlled to give evaporation rates approximating those of straight-run lacquer diluent, V.M. and P. naphtha, and mineral spirits; in Class 3 the two principal solvents are 2° toluol and 10° xylol. The characteristics and the uses of each are discussed, and six literature references are given. W. H. C.

**817. Petrochemical Industry in the Southwest Builds for Growing Peacetime Market.** D. P. Thornton. *Nat. Petrol. News Tech. Sect.*, Jan. 1946, **38** (1) R3–8.—The States of Texas, Oklahoma, Kansas, and Arkansas in the southwest of the United States appear well favoured for the expansion of the petrochemical industry, in view of the vast production of natural gas, refinery gases, and petroleum from the refining installations which have been much augmented by war needs for the production of petroleum products, toluene, butadiene, butyl rubber, and styrene. A good labour supply is available, as well as good climatic conditions for outdoor plant structures, and, particularly in Texas, for waterside loading and transport. This survey includes a map and list showing the State and towns having plants for the synthesis of organic chemicals (existing and projected), the company operating, raw materials employed, products manufactured, and actual or estimated plant costs. The list covers 11 petroleum concerns, 9 chemical manufacturers, 1 synthetic rubber company, 2 Ordnance works, and 1 military chemical works, situated in 16 localities. During the war, five of these companies have been producing toluene, and therefore possess superfractionating equipment, a prerequisite for the production of some classes of chemical products. The economics of the subject are discussed from a wide angle, and some views of various experts are given. W. H. C.

## Derived Chemical Products.

**818. Phthalic Anhydride from Petroleum.** F. R. Staley. *Oil Gas J.*, 25.5.46, **45** (3), 118.—The process is described by which phthalic anhydride is manufactured from orthoxylene, itself produced from crude oil.

Standard Oil Co. have built a million-dollar plant at Richmond, California, in

which vapourized xylene, mixed with air at high temperatures, is fed to a multiple-tube converter where the phthalic anhydride is formed.

The considerable heat developed must be removed quickly by circulation of a cooling-liquid. The anhydride vapours are cooled in a series of five condensers, the deposit removed to tanks, where it is liquefied and pumped to two stills, impurities being removed by fractionation. The product, practically 100% pure, is stored in aluminium tanks and later flaked into package. G. A. C.

**819. Chemicals from Petroleum.** Sir Frank Smith. *J. Roy. Soc. Arts*, 12.10.45, **45** (4702), 566–598.—Three lectures given before the Royal Society of Arts are recorded. The first briefly outlines the scope of the petroleum industry and gives some statistical data covering the years 1924–1943. The raw materials used—*i.e.*, mainly petroleum—together with natural and refinery gases, and the products derived from thermal and catalytic cracking are considered in detail, and the manufacturing of various chemicals from them are illustrated by numerous diagrams, showing the changes in structure taking place, viz. methane → carbon black, methanol, formaldehyde. Ethylene → ethyl alcohol, ethyl chloride; ethylene dichloride, vinyl chloride; trichloroethane, vinylidine chloride; ethylene chlorohydrin, acrylonitrile, glycol; ethyl benzene, styrene. Propylene → isopropyl alcohol, acetone; allyl chloride, allyl alcohol; isopropyl benzene (cumene) and, similarly, the products derivable from acetylene, and from hydrogen and carbon monoxide by the Fischer-Tropsch synthesis are shown.

Lecture 2 relates to the production of polymers, particularly the manufacture of synthetic rubbers; polymerization is outlined and discussed; formulæ, types, and structures of polymers are shown, and the length of polymer chains in some well-known polymers is given. Molecular forces are also discussed, and the attraction and repulsion of molecules are shown in three curves, illustrating what happens when gases change by polymerization into liquids and finally solids, and what forces keep the chains together and govern the mechanical properties of the final product. Molecular polar forces, miscibility of liquids and dielectric properties are discussed. Fifteen synthetic rubbers are listed, with the raw materials from which they are manufactured. The principal synthetic rubbers are: Buna N, which is manufactured from butadiene and acrylonitrile; Buna S, from butadiene and styrene; Butyl, from butene and a diolefin such as butadiene; Neoprene, which is made from chloroprene. Butadiene and these synthetic rubbers are discussed as to their manufacture, structure, characteristics, and uses. The effects of vulcanization are described.

Lecture 3 deals with plastics and synthetic chemicals for fuels. The characteristics of plastics, their structural formulæ, uses, and methods of manufacture are described and discussed, special emphasis being given to their electrical properties, which are shown in tabulated form for: polyethylene, polyisobutylene, polystyrene, polyvinyl chloride, polymethylmethacrylate, in comparison with rubber. Co-polymers of polyvinyl chloride and polyvinyl acetate, etc., are mentioned, and condensation type polymers, *e.g.*, phenol formaldehyde, the original "bakelite," and nylon, are discussed and their formulæ given. An outline of the use of synthetic hydrocarbons for fuels is given, and their structural formulæ are shown. The relation between their structures and efficiency in internal-combustion engines is discussed, a graph shows the approximate relation between octane numbers and the number of methyl groups in the paraffin chains. Iso-octane, neohexane, and cumene are discussed.
W. H. C.

## Coal, Shale and Peat.

**820. Organic Acids by Direct Oxidation of Coal.** N. W. Franke and M. W. Kiebler. *Chem. Ind.*, April 1946, **38** (4), 581–2.—A brief description is given of a process by which aromatic polycarboxylic acids are produced by the admission of oxygen into a mixture of powdered coal and sodium hydroxide solution in a pressure vessel, continuously stirred and heated at 200–500° C under 500–1200 p.s.i. for 2–3 hours. The subsequent treatment includes: cooling, filtration (to remove ash), acidification, solvent extraction, and concentration. "All the carbonaceous matter of the coal passes into solution, with about half of the carbon of the coal being oxidized to organic acids and the balance to carbon dioxide." The solvent extraction recovers 95% of the acids; the product after solvent removal is a syrupy liquid containing

from 50% to 70% by weight of dissolved acids. Concentration of the syrup in a vacuum drier leaves a hygroscopic, light-brown powder which is very soluble in water and is strongly acidic. The yield is over 50% of the coal charged. The acids are approximately 50% carbon, have an average equivalent weight of 80 and an average molecular weight of 250. Less than 0·5% is volatile, and the ash content is under 0·4%. Acetic acid and oxalic acid are present up to 1%. The average analytical properties correspond approximately to those of a mixture of tri- and tetrapoly-carboxylic benzene acids. Acids having a more complex nucleus than the benzene ring are undoubtedly also present. The esters formed from the acids with mon-, di-, and poly-hydric alcohols are discussed; they are hard resins, insoluble in water, and are considered to be useful as plasticizers and as tackifiers for use with synthetic rubbers. Partial esterification of the acids leaves free carboxyl groups in a hydrocarbon soluble material, which should find uses in the formation of oil additives and detergents. A wide range of uses is anticipated for these acids—*e.g.*, for plastics, starting points for synthesis, etc.—since they undergo the usual reactions characteristic of the carboxyl group and have, in addition, the properties peculiar to polycarboxylic acids. W. H. C.

**821. Commercial Methods for Manufacturing Wax in Germany are Described. Part 3. Some Solvent Extraction Developments in Germany.** J. P. Jones. *Nat. Petrol. News Tech. Sect.*, 3.4.46, **38** (14), R-273.—Both hard and soft wax was made by solvent extraction with $SO_2$ from tar distillate secured by low-temperature carbonization of brown coal and, to a limited extent, from shale oil. Centrifuging was used followed by two-stage extraction with $SO_2$. Dichloroethane was used in the dewaxing step. By a proper choice of the dewaxing temperature it is possible to keep the undesired components of the total wax and of the soft wax in the filtrate. The separation of waxy components by dewaxing the $SO_2$ raffinate, or by after treating the total wax or soft wax from the tar fraction at different temperatures with dichloroethane, depends on the materials contained in these fractions, and particularly on the melting points of the wax components—*i.e.*, in this case, also on the molecular weight. In wax mixtures containing straight-chain paraffins, isoparaffins, and cyclic compounds, the melting point is of primary importance in determining the separation conditions, since cyclic hydrocarbons which have the same melting point but a different molecular weight from the paraffin hydrocarbons will be separated in the same filtrate. It is shown that by treating wax which has been obtained at a temperature of − 20° C with dichloroethane at − 10° C the low-boiling (paraffin hydrocarbons) and the highest-boiling (primary cyclic hydrocarbons) will go into the same filtrate, so that from a total wax fraction, obtained by dewaxing at − 20° C, there can be obtained only soft wax components, by an after treatment at − 10° C and the low-melting components will be brought into solution, including those with a melting point of 20° C. By after treatment at − 5° C all soft wax components having a melting point up to about 25° C will be separated, or in the case the former dewaxing temperature has been changed to the temperature of this after-treatment, these soft wax components will remain in solution. The investigations discussed in this paper relate to the wax in brown coal and shale oil. The data of fractional separations of the above nature for total wax and soft wax are discussed and shown in tables and three graphs. The dewaxing process as practised at the A.G. Sachsischewerke, Espenhain, and the results of operations on tars from brown coal are given. Some data on shale oils, processed, are included. W. H. C.

## Miscellaneous Products.

**822. Use of Chemical Additives in Petroleum Products.** L. A. Hamilton and P. V. Keyser. *Nat. Petrol. News Tech. Sect.*, 6.3.46, **38** (10), R-228.—A review of the developments of additive agents for fuels and lubricants is presented. Those for fuels are divided into: (1) Gum inhibitors or oxidation stabilizers; (2) Combustion assistants, (*a*) Anti-knock agents, (*b*) Cetane number improvers, (*c*) Combustion assistants for burner fuels; (3) Catalyst deactivators. Each section is discussed, and a tabulation shows the principal commercial additives for fuels in use at the present time, which gives seven anti-oxidants, and two copper deactivators—viz., di-salicyclal propylenediamine and salicyclal-*o*-aminophenol. In groups (*b*) 2 : 2-dinitropropane is announced as a new cetane number improver which is both effective

and remarkably stable in the fuel under long time storage conditions. So far combustion assistants have not been used commercially. The compounds studied for this purpose have been organic compounds of the catalytic metals—*e.g.*, Co, Ni or Cr. Additives for lubricants are shown classified under eight sections: Pour-point depressants; Viscosity index improvers; Stabilizers (oxidation inhibitors) for turbine oils, motor oil stabilizers and bearing corrosion inhibitors; Detergents; E.P. agents; Oiliness agents; Rust inhibitors and anti-foam agents. Each section is discussed as to type of chemical compound and use. Literature or patent references are in many cases included. Tabulations are given of: Commercial types of motor oil stabilizers; Compounds used to improve the lubricating properties of oils and extreme pressure lubricants; Types of additives believed to have been used in various commercial oils at various times; and the number of patents (U.S.) for lubricant additives issued in 1944, classified by probable function and by composition. The theories that have been advanced to explain the mechanism of autoxidation of hydrocarbons are outlined and the subject is discussed as to future developments. Many literature references are given under 13 headings. W. H. C.

**823. Teflon. New "Noble Metal" of the Plastics.** Anon. *Chemical Ind.*, May 1946, **58** (5), 781.—Teflon, at present available from pilot-plant operation, is a transparent substance in thin sections, white or grey in thicker pieces. It is tough over a wide range of temperatures, has excellent electrical properties, is chemically inert, and has high heat distance.

No suitable plasticizer has yet been found for Teflon, which undergoes a solid phase transition to a gel at 325° C, with a fall in strength.

Teflon can be extruded as rods, tubes, and as a wire-coating; compression mouldings of simple shapes can be made and sheets and thin films produced. Heavy tubing can be threaded.

The field for Teflon is limited mainly to the manufacturing of electronic parts subject to high-frequency current and high temperature. Present production is 10,000 lb per month, priced at $12 to $15 per lb, which may be reduced to $2.50 per lb on large-scale production. G. A. C.

## Engines and Automotive Equipment.

**824. German High-Powered Diesel Engines.** Anon. *Motor Ship*, July 1946, **27** (318), 130.—In a review of "German Diesel Engine Industry" issued by British Intelligence Objective Sub-Committee, the "Motor Ship" details the following engines:—

1. At the M.A.N. works at Augsburg the largest unit (intended for installation in a battleship) was a two-stroke, double-acting engine having two vertical banks of 9 cylinders arranged side by side, with crankshafts operating separately, but with a common crankcase and bedplate. Each bank developed 14,650 B.H.P. at 255 r.p.m., the cylinder bore and stroke being 25·6 and 37·4 inches. The corresponding mean indicated pressure in the cylinders is 69·2 lb/sq. in., the specific weight 30 lb/B.H.P., and the fuel consumption 0·414 lb/B.H.P. hr.

2. Another unit at Augsburg, found partly dismantled, was designed for much higher speed—450 r.p.m.—with cylinder bore and stroke of 16·6 and 22·8 inches and was constructed as a V-type 24 cylinder set with an output of 16,500 B.H.P., the corresponding M.I.P. being 65 lb/sq. in.

3. A third double-acting two-stroke engine of still higher power was to be developed for installation in a destroyer, with 6 units totalling 60,000 B.H.P. This was a 24-cyl. V-type equipped with mechanically driven centrifugal blower, and was subjected to a 72-hour test at 15,000 B.H.P. The bore and stroke were 12·6 and 17·32 inches and speed 600 r.p.m. From the power of 12,000 to 15,000 B.H.P. super charging took place by means of an exhaust turbo blower. Specific weight was 18·7 lb/B.H.P.

4. The most successful German submarine engine was the 6-cyl. 4-stroke single-acting pressure-charged series with cylinder bore 15·75 and stroke 18·1 inches developing 2400 B.H.P. at 540 r.p.m. The corresponding mean indicated pres-

sure is 166 lb/sq. in., specific weight 14·7 lb/B.H.P., and fuel consumption 0·355–0·380 lb/B.H.P. hr.

5. A new model developed during the war was a 12-cyl. V-type with bore 18·1 and stroke 13·4 inches. It has an open combustion chamber and develops 2000 B.H.P. with fuel consumption of 0·37 lb/B.H.P. hr., specific weight 11 lb/B.H.P. The mean pressure is 141·5–160 lb/sq. in. (indicated) and speed 850–900 r.p.m. corresponding to 1900–2050 ft/min. The type is turbo-charged.

I. G. B.

**825. An Analysis of Intercooled Supercharging.** R. Miller. *Motor Ship*, July 1946, **27** (318), 150.—On the basis of constant internal temperatures, the non-air-cooled Buchi supercharging system permits an increase of 28–30% on the B.H.P. of the non-supercharged engine or an increase of between 20 and 28 B.M.E.P. The cost of equipping an engine with a turbocharger and the Buchi exhaust-pipe system is very nearly in the ratio of this increase, so that the final cost per B.H.P. of the supercharged engine is approximately the same as the cost of the standard non-supercharged engine.

By the simple expedient of adding to the supercharging equipment an air cooler whose dimensions may be 15 inches square by 4 ft long for 2600 c.f.m. and supplying cooling water at 80° F to remove 3 B.Th.U./minute/B.H.P., the engine output is increased to 155% of non-supercharged rating.

The cost of this cooling equipment will be about $3–$4 per H.P. gained by cooling. The author believes this to be the lowest cost on record for a diesel-engine horsepower. The extreme simplicity of equipment and ease of operation and maintenance should bring about universal acceptance of intercooling and render the uncooled turbocharged engine obsolete.

Compared with the non-intercooled turbocharged engine, intercooling to 90° F reduces the cost per H.P. by about 18½%. The weight and volume of the engine are reduced about 20% for the same horsepower.

Beyond this lies high-pressure intercooled supercharging using multiple-stage turbochargers, which promises in the near future to revolutionize the design of internal-combustion engines. Those engineers who accept the challenge of this discovery and bend their efforts towards the solution of the problems involved in developing this new engine will help to guide the internal-combustion engine industry towards greater expansion and increased importance in our civilization. I. G. B.

**826. A Middle-Weight Power Unit.** Anon. *Aeroplane*, 14.6.46, **70** (1829), 697.—Details are given of the new 500-h.p. Alvis Leonides 9 cyl, air-cooled radial aircraft engine :—

*General Data.* 9 cyl.; 4·80-in bore and 4·41-in stroke; 718·5 cu. in. capacity; 6·8 : 1 compression ratio; fuel 100 octane 5·5-c.c. T.E.L. content (type test ratings have been obtained on 87 octane fuel); 6·5 : 1 supercharger ratio; 41·5 inch overall diameter and 52·8 inch length, with accessories.

*International rating.* B.H.P. 425; r.p.m. 2900; boost + 3 lb/sq. in.; altitude 9000 ft; fuel consumption 0·6–0·66 pt/b.h.p./hr.

*Maximum power rating.* B.h.p. 515; r.p.m. 3000; boost + 6½ lb/sq. in.; altitude 4000 ft; fuel consumption 0·68–0·75 pt/b.h.p./hr.

*Fuel system.* Fuel metering unit, Hobson Mark 1 CHA 48150; boost control, Hobson Mark 53; throttle housing, Hobson Type A.L.1, oil heated.

*Lubrication system.* Specification DTD 2472 B/2; normal oil pressure 60–80 lb/sq. in.; consumption 3–7 pt/hr.; maximum inlet temp. 80° C; normal max. outlet temp. 110° C; normal oil flow 300 gal/hr.

*Ignition.* Magnetos (two) B.T.H. C.2S.E.9s or C.9A/2; plugs, Lodge 107R.

*Weight.* Net dry (engine), 742 lb; power plant complete 1150 lb.

I. G. B.

**827. A 6000 B.H.P. Gas Turbine Installation.** Anon. *Motor Ship*, July 1946, **27** (318), 130.—A short account is given of the proposed layout of a 6000-B.H.P. open cycle gas turbine for a ship installation, but no hint is given whether such an order has been received by the makers (Messrs. Brown, Boveri). The cycle is the usual

simple preheated type with efficiency 26·5% (0·53 lb/B.H.P. hr.) and gas temperature 600° C. The specific weight is 73 lb/B.H.P. There are two power turbines, with an ahead and astern section for each, and they operate at 4300 r.p.m., driving the single propeller shaft through reduction gearing at 110 r.p.m. A fixed propeller is employed. The engine-room is about 15% shorter than that of the corresponding diesel engine installation, and the cost is equivalent to a direct-coupled diesel installation.

I. G. B.

**828. High Temperature Gas-Turbine Plant.** Anon. *Motor Ship*, July 1946, **27** (318), 144.—Allis Chalmers have installed in the U.S. Naval Engineering Station at 3500-B.H.P. experimental gas turbine for operation at high turbine inlet temperatures. The cycle layout is characterized by a two-shaft system, the first being the compressor and compressor-turbine, and the second the power turbine coupled to a dynamometer. The air, after compression, enters the preheater, and is then split into two streams, one to the combustion chamber feeding the compressor turbine and the other to the power turbine. The exhaust gases from the two turbines are collected and passed through the hot side of the recuperator.

Tests have recently been completed at 1300° F, and it is intended to increase this to 1500° F. The cycle characteristics at the latter temperature are as follows: air intake 181,665 lb/hr, 60° F, 14·49 lb/sq. in.; compressor exit 363° F, 58·85 lb/sq. in.; air from recuperator 750° F, 57·56 lb/sq. in. (60% effectiveness); gas from compressor-turbine combustion chamber 1500° F, 56·54 lb/sq. in., 114,750 lb/hr.; gas from power turbine combustion chamber 68,750 lb/hr., 1500° F, 56·54 lb/sq. in.; gas to recuperator 1024° F, 15·16 lb/sq. in.; exhaust gas to stack 183,500 lb/hr., 637° F, 14·75 lb/sq. in.

In the combustion chambers there is a variable port arrangement controlling the flow of the proper volume of air for complete combustion into a central flame zone. The temperature of combustion gases is 3000° F. These are given a swirling motion in the tube, and external fins on the tube rotate the excess air in the opposite direction. The heat release is $2{\cdot}5 \times 10^6$ B.Th.U./(ft$^3$)(hr.). It is proposed to use Bunker C oil in commercial installations: the test unit uses No. 2 furnace oil.

In order to obtain a thermal efficiency of 40%, certain modifications would be necessary. The compressor would be in two sections, intercooled and the turbines in series with reheating. The regenerator surface would be greatly increased.

I. G. B.

**829. Rolls-Royce Nene I.** Anon. *Flight*, 18.4.46, **49** (1947), 389.—*Flight* gives the following description of the most powerful turbine-jet unit in full production:—

| | |
|---|---|
| Diameter | 49·5 in. |
| Length, to turbine | 63·9 in. |
| Length, including exhaust cone | 96·8 in. |
| Weight, less jet pipe | 1550 lb. |
| Weight, jet pipe | 9·5 lb/ft. |
| Fuel—Aviation Kerosine + 1% lubricating oil | 0·806 sp. gr. |
| Fuel consumption, sea-level static 4000 lb thrust | 1·055 lb/lb/hr. |
| Fuel consumption, sea-level static 5000 lb thrust | 1·065 lb/lb/hr. |
| Air consumption, 5000 lb thrust | 89 lb/sec. |
| Compression ratio | 4 : 1 static |
| Maximum speed | 12,300 r.p.m. |
| Maximum thrust | 5000 lb. |
| Compressor impeller, peripheral velocity | 1530 ft/sec. |
| Turbine rotor, mean blade speed | 1070 ft/sec. |
| Acceleration 2500–12,300 r.p.m. | 4·5 sec. |

I. G. B.

## MISCELLANEOUS.

**830. Cost of Discovering New Petroleum Reserves Continued to Increase in 1945.** H. J. Struth. *Petrol. Eng.*, Feb. 1946, **17** (5), 51.—2,180,000,000 brl of new reserves was added in U.S.A. in 1945, while the production of 1,706,000,000 brl was an all-

time high. 60% of the new reserves was credited to discoveries made in previous years. 4105 wildcats and 6424 development dry holes were among the 27,045 wells drilled in 1945.

Between 1936 and 1940 the cost of finding oil, including all subsequent extensions and revisions, was about 10·5 cents/brl; initial finding costs in 1945, excluding future extensions and revisions, was 63·4 cents/brl. On the basis of past experience allowances for future extensions and revisions may reduce the 1945 figure to 49·6 cents/brl.

Ignoring the increased cost of developing new pools, and increased production costs in developed fields, the present price of crude oil is 27–35 cents/brl below bare economic existence levels.

The total cost of exploratory operations in 1945 is estimated at $721,247,000, compared with $553,226,000 in 1944.

Except for a moderate increase in reserve discoveries in 1944, there has been a downward trend since 1937. The average for the past 5 years is 56% below that for the preceding 5 years. In 1945 11 dry holes were drilled per million barrels of new reserves discovered; in 1937 the figure was 2 dry holes, and in 1930 1 dry hole per million barrels of new reserves. Prior to the last five or six years the ratio of discoveries, including revisions and extensions, to production has been 1–1½ (omitting the 5-year period ending 1930). During the past five years the ratio has been 0·64.

In 1945 6·19 discovery wells were needed to find 1,000,000 brl of new oil; the 1944 figure was 4·67 wells. In 1945 the cost of discovering 1,000,000 brl of new oil was 30% above the 1944 figure.

Numerous tables and diagrams present data on costs, reserves, discoveries, and drilling. G. D. H.

**831. Third List of Definitions.** Standardization Sub-Committee No. 11.—Nomenclature. *J. Inst. Petrol.*, May 1946, **32** (269), 289–291.—The following terms are defined: Amorphous wax, blending, blown oil, casinghead gasoline, ceresin, compounding, co-polymers, crude oil, earth wax, extract, hydraulic fluid, insulating oil, long-time burning oil, marine engine oil, microcrystalline wax, mineral colza, mineral jelly, mineral oil, mineral seal, mineral sperm, ozokerite (earth wax), paraffin scale, paraffin wax, petrolatum (petroleum jelly, mineral jelly), petroleum ceresin, petroleum resins, polymerization, polymers, pour point, power kerosine, pressure distillate, raffinate, scale wax, shale oil, signal oil, soft paraffin, solar oil, special boiling point spirit, spindle oil, stabilized gasoline, steam cylinder oil, transformer oil, turbine oil, vaporizing oil, white scale. A. H. N.

**832. United Kingdom Petroleum Imports and Exports.** Anon. *Petrol. Times*, 11.5.46, **50** (1273), 487.—Statistical data for March and the first three months of 1946 are given. A. H. N.

# BOOKS RECEIVED.

**Reaktziya Alkilirovaniya v Proizvodstve Aviatzionuikh Topliv. (The Alkylation Reaction in the Production of Aircraft Fuels.)** By Yu. G. Mamedaliev. Aznefteizdat, Baku, 1945. Pp. 163. Price 24 rubles.

This monograph is issued under the joint auspices of the Azerbaidzhan Scientific Research Institute of the Petroleum Refining Industry and the Azerbaidzhan State University, in whose laboratories the experimental work described was carried out.

The book is divided into two parts, dealing with the catalytic alkylation, by unsaturated hydrocarbons, of aromatic hydrocarbons and of *iso*-paraffins respectively.

After a theoretical discussion, and a brief description of the various methods available for the alkylation of aromatics, which are conveniently summarized in tabular form, the greater portion of the first part is devoted to an account of the

author's own work in this field. The raw materials taken (benzol and unsaturated hydrocarbons from cracking processes) are fully described, and a detailed account is given of the alkylation of benzol with propylene, butylene, amylenes, and with mixed low-molecular-weight unsaturated hydrocarbons, using cold sulphuric acid as the alkylation catalyst. A final section gives some results of alkylation using a solid catalyst.

In the second part the alkylation of *iso*-paraffins is considered. After a short introductory section, dealing with the theoretical aspects and with previous work, there again follows a detailed account of the author's own investigations. The starting materials employed were the front ends (up to $C_5$) of cracked and casing-head gasolines. Sulphuric acid was again used as the principal alkylation catalyst. There is a brief discussion regarding the utilization of spent acid from the alkylation process, and results are given showing that this is quite suitable for use for the acid refining of lubricating oils.

This book summarizes in a useful form the theoretical aspects of alkylation, together with previous work on the subject. The experimental sections, dealing with the author's own work, are set forth in very considerable detail, there being, for instance, over 100 tables of experimentally obtained figures. This part of the work is really, inasfar as detailed description is concerned, more akin to an individual scientific paper than to a publication of the book type, although in a monograph such as the present one, dealing with a relatively narrow field, there is much to be said for such detail, especially as it does not appear as though the author had previously published any of this work, his name appearing but once in the list of 144 references to the literature that is given. It would have been of considerable assistance had the author, at the end of each part, summarized his own findings, which are otherwise somewhat lost in a mass of detail.

The experimental data given is commendably free from a tendency, which, in the reviewer's experience, is fairly common in Russian publications, of quoting results to a greater degree of apparent accuracy than the particular test in question warrants, although in one instance (Table 98) the viscosities of a lubricating oil are given to 5 significant figures. The text of the book is satisfactorily free from mis-prints, one noticed was in Table 22, where the first of the products should evidently read "petroleum benzol"; in the list of literature references, however, there is on several occasions, in the case of U.S. journals, a discrepancy between the volume numbers and the years quoted. V. B.

**Chemical Treatment for Drilling Mud.** New York: American Cyanamid & Chemical Corpn. 1945.

A booklet of data on drilling mud based on the revision of a series of articles published in American journals during 1940–41.

**Industrial Experimentation.** K. A. Brownlee. London: H.M. Stationery Office, 1946. 116 pp. 2*s*. 0*d*. net.

A compendium of the formulæ used in applying statistical methods to experimental work.

**Alberta Oil Review for 1945.** J. L. Irwin. Edmonton, Alberta: Dept. of Economic Affairs, 1946. Pp. 31.

Crude oil production in Alberta in 1945 totalled 8,055,440 barrels, a reduction of 733,286 from the 1944 figure of 8,788,726, which in turn was 885,822 barrels less than in 1943. Total decrease in Turner Valley's output in 1945 was 904,253 barrels, fields outside of the Valley showing an increase of 170,967 barrels.

Detailed statistics and information regarding the various fields are given, together with statistics for British Empire petroleum production from 1932 to 1945.

# ABSTRACTS.


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## Oilfield Exploration and Exploitation.

### Geology.

**833. Classification of Petroleum Reservoirs.** O. Wilhelm. *Oil Gas J.*, 23.2.46, **44** (42), 171.—Typical oil-traps are due to a combination of two or more of a group of factors: (*a*) the attitude of the beds in the reservoir area; (*b*) convexity of the surface of the reservoir bed due (1) to folding, (2) to thickness variation, (3) to porosity variation; (*c*) lateral variation or interruption of porosity and permeability by lithological changes in a bed; (*d*) stratigraphic pinch-out of a bed; (*e*) structural interruption of a bed by faulting or piercement.

Reservoirs may be grouped as follows: (1) Convex traps; (2) Permeability trap; (3) Pinch-out traps; (4) Fault traps; (5) Piercement traps.

Examples are given of combinations of factors, and there is a tabular classification. G. D. H.

**834. Permeability Trap Reservoirs.** O. Wilhelm. *Oil Gas J.*, 9.3.46, **44** (44), 91.—Changes of permeability may cause trapping of oil, and a typical permeability trap has the edgewater limit interrupted on the up-dip side of the reservoir and replaced by an impermeable barrier. Convex traps may be modified on one side by a permeability barrier.

Diagrams show various modifications of permeability traps. G. D. H.

**835. Feather-edge-porosity Reservoirs.** O. Wilhelm. *Oil Gas J.*, 16.3.46, **44** (45), 121.—Certain permeability traps are due to changes of lithology or texture, or to cementation or solution. These reservoirs are commonly described as due to feather-edge porosity. Delta and shoreline deposits provide feather-edge porosity conditions. Limestones afford examples of feather-edge porosity, and asphalt may give rise to some permeability traps. Accumulations may occur in zones of fracture in limestone, sandstone, chert, or siliceous shale. In these cases the wells are frequently along clearly defined zones of disturbance. G. H. D.

**836. Lenticular Reservoirs.** O. Wilhelm. *Oil Gas J.*, 23.3.46, **44** (45), 115.—Lenticular reservoirs are due to normally interbedded porous lenses, to erratic inclusions of porous rock, or to lenticularity in permeability conditions. Their production always follows the gas-drive depletion pattern, and they may occur on almost any type of structure or where no structure is present.

The shoestring fields of the Mid-Continent are of this type, which is also represented in the Appalachian region. The erratic igneous reservoir rocks of the Balcones fault zone also belong to this type. G. D. H.

**837. Location, Depth, and Initial Production of Discovery Wells.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 214.—Brief notes are given on the discovery wells in the new fields

and pays in U.S.A., with the depth, producing formation, initial output, and other data. G. D. H.

**838. January Completions Gain.** Anon. *Oil Wkly*, 25.2.46, **120** (13), 30.—During January, 1946, U.S.A. wildcat completions averaged 80·4 per week. The December 1945 figure was 74·8. 15·9% of the January tests were successful. 26 oilfields, 13 gas-fields, and 2 distillate fields were found; there were 7 new oil-pays, 1 gas-pay, and 3 distillate pays, and 8 oilfields extensions and 4 gas-field extensions.

Tables summarize the discovery results by States and districts, and list the new discoveries together with brief details. G. D. H.

**839. Townsite Drilling Campaign Latest Development in Complex Cement Pool.** K. B. Barnes. *Oil Gas J.*, 9.3.46, **44** (44), 70.—The Cement pool is marked by a surface anticline. Development started 30 years ago. The productive area is 13,000 acres. New activity has begun between the east and west domes.

In June 1945 a 300-brl well was completed in the Middle Rowe sand, and an 80,000,000-cu. ft/day gas-well has been drilled in the Lower Rowe sand. 7 flowing wells and 3 pumping wells have been completed in the new developments. These wells average 4500 ft in depth. The predominantly oil-bearing horizon of the Noble-Olson sand occurs at about 3400 ft. Between 3700 and 4300 ft are the four sections of the Rowe sands; the Yule sand is at 5200 ft, the Wade sand at 5300 ft, the Upper Kistler at 5500 ft, and the Marchand sand may be at 6300 ft. The Medrano and Marchand sands are outstanding. The former is a flank deposit on the south flank of the west dome. It is 5600–6000 ft deep and 127 ft thick. Several large gas-wells have been completed in it. Oil has been found down-dip. The Marchand also is a flank sand, being on the south side of the east dome at 6500–7200 ft. It is 300 ft thick. There is no gas cap. 24 wells have been completed in the Marchand. G. D. H.

**840. Phillips Cores Oil-Sand in First Venezuelan Well.** Anon. *Oil Gas J.*, 23.3.46, **44** (46), 61.—In Phillips Venezuelan Oil Co.'s first Venezuelan test well, FT-1, oil-saturated sand has been cored at 4675–4702 ft in the La Pica formation. This formation generally has oil-sands up to several hundred feet in thickness in this locality. The well is on the Mata Grande block in Monagas. G. D. H.

**841. Southern Chile Wildcat Shows 8000 Brl Daily.** Anon. *Oil Gas J.*, 23.3.46, **44** (46), 64.—The Spring Hill wildcat on the Straits of Magellan has shown a potential of about 800 brl/day on test. The oil in this 7500-ft well is of 33° A.P.I. gravity. G. D. H.

**842. Joya Mair Tests Await Construction of Storage.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—Two wells at Joya Mair have each indicated a production of 9000 brl/day of heavy oil on short tests. G. D. H.

**843. Resumption of Drilling in Philippines Soon.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—Before the war encouraging oil indications were found in northern Cebu in a well taken to 8330 ft. Drilling in the Philippines may soon be restarted. G. D. H.

**844. Atlantic Deepening Well on its Haiti Concession.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—Jurinet 1 was originally abandoned in August 1944 at 7005 ft in the Lower Oligocene. Drilling has now been re-started, and is below 7300 ft. The well is 50 miles northeast of Port-au-Prince. G. D. H.

## Geophysics and Geochemical Prospecting.

**845. Submarine Prospecting.** R. Sneddon. *Petrol. Engr*, May 1946, **17** (8), 222.—A new bathysphere has recently been tested. It is intended to permit an operator to take gravimeter readings from a permanently level surface rather than from the rising and falling surface of a boat deck. It is 3 ft in diameter and 5 ft high, and capable of standing immersion to 100 ft. Portholes are provided for examining the sea floor

when it is illuminated by a spotlight. If necessary the chamber can be released from the heavy base, and it will then rise to the surface.

The internal fittings include oxygen supply, air purifier, and telephone.

It is not intended that the bathysphere shall be lifted on board at every move, but that it can be made fast and towed. G. D. H.

## Drilling.

**846. Engineering Refinements Feature New Heavy Rig.** G. Weber. *Oil Gas J.*, 11.5.46, **45** (1), 95.—The rig is powered with 3 engines totalling 975 h.p. Designers of the rig have centralized all control levers and instruments in one panel located at the driller's position. Small hand levers actuate the air-valves that operate all clutches in the draw-works transmission, on the compound drive, hydromatic brake, rotary pumps, and sand reel. Hand throttles in the panel control the engines singly or in compound, and the control may be transferred to a foot pedal for use in hoisting. Instruments showing air pressure, engine vacuum, transmission-shaft speed, and oil pressure are also installed in this panel. An auxiliary instrument panel installed in front of the draw-works shows pump and bit pressures and rotary speed. Two additional foot pedals at the driller's panel actuate the air-operated friction clutches to the rotary and automatic rotary-side cathead. Complete pneumatic operation of the rig is made safe and dependable by adequate compressor capacity. Three compressors, driven individually by the three prime movers, afford an immediate pressure build-up on starting any engine. Since two compressors are capable of maintaining sufficient air pressure, the third is available as a virtual standby. The large-duel-type air reservoir is mounted on the compound drive, and is equipped with safety valves and water traps to remove all condensate from air lines. The pneumatic system operates best at 125 p.s.i. In case of emergency, clutches on compound transmission, and pump can be operated manually. Engine and low-speed drum clutches can be locked in position allowing the rig to be operated without air. The hoisting and other important units of the rig are described. A. H. N.

**847. Large Rig Pneumatically Controlled.** K. M. Fagin. *Petrol. Engr*, May 1946, **17** (8), 51–54.—Details of a new large power-type rotary drilling rig manufactured by Oil Well Supply Co. are given. The rig has been used on drilling down to 9200 ft and was designed for 16,000 ft depths. Pneumatic controls for the clutches are used. A. H. N.

**848. Hydraulic Hoisting Used In Proposed Rotary Rig.** N. Williams. *Oil Gas J.*, 18.5.46, **45** (2), 148.—A working model of rotary rig which is equipped with hydraulic jacks is described. A radical departure from conventional equipment, the hydraulic hoisting system as applied to the working model has as its essential elements three high-pressure cylinders with their reciprocating lifting plungers, a centrifugal pump to circulate the activating fluid, fluid transmission lines to and from the cylinders, a control-valve arrangement, a primary power source for the pump, and a fluid supply tank. The hoisting assembly is built into and forms an integral part of the derrick mast. In this, two of the hydraulic cylinders with their tubular supports comprise the two front legs of the mast. Use is made of the tubular supports for transmission of activating fluid to and from the cylinders. The third cylinder is suspended by a differential-joint connection, allowing free movement, from the centre of a horizontal crosshead connecting the tops of the lifting piston rods which extend upward from the hydraulic cylinders forming the mast leg members. Attached by a hinge-pin connection to the bottom end of the piston which extends downward from the centre cylinder is a hook of more or less conventional type, from which the swivel, kelly, and drilling-string load is suspended in conventional manner. The operation of the rig is described. A. H. N.

**849. Portable Mast Takes to Water.** P. C. Courtney. *Oil Gas J.*, 20.4.46, **44** (50), 141.—From the discussion in the paper it appears that economic advantages obtainable from use of portable masts and derricks on land may be expected also from their use on water locations. Incorporated into the design of the portable masts operating in coastal waters are two features which have contributed greatly to safety and efficiency. One involves the elimination of extensive interior bracing so that the driller can have a clear, unobstructed view to the derrick man. The other feature

enables the driller to erect the derrick without having a slack line during the process. The interior bracing, essential to support the front legs in all open-face masts, has been eliminated by lacing all four sides. This, of course, necessitates racking the drill pipe inside instead of outside the base. Since the space occupied by racked pipe is as great at the top of the stands as it is on the derrick floor, it was necessary to design the mast so that the inside area at the working-board level would not only provide for free movement of the travelling block, but would also accommodate the working boards and the full pipe setback. This results in a bulge in the mast.

In conventional masts a safety hazard is encountered during erection due to the hoisting line becoming slack when the centre of gravity of the structure passes over the supporting pin. This condition is avoided in the bulge-type mast by a base design which causes the centre of rotation to shift automatically from the front to the rear legs just before that critical point is reached. This eliminates the possibility of the mast falling back into the ginpole during erection and obviates the necessity of pulling it over centre when lowering. A. H. N.

**850. Penetration Rates in Hard Formation Drilling.** J. E. Warren and R. B. Schabarum. *Oil Gas J.*, 8.6.46, **45** (5), 82. *Paper Presented before A.P.I.*—To find out whether the bit in a rotary drilling rig grinds the cuttings to fine dimensions, a basket was placed above the bit. Cuttings collected from the basket are very large compared with those appearing at the surface. It is concluded that the large cuttings are ground up in the annulus by the drill-pipe collars and tool joints against the walls of the well.

The economics of drilling as affected by hole size are discussed. A. H. N.

**851. Drilling Tower for Continental Shelf Use.** G. B. Nicholson. *Oil Wkly*, 20.5.46, 121 (13), 34.—An octagonal tower built in sections of tubular components is proposed for continental shelf drilling. A model of the tower is described in the paper as the full scale prototype has not been built as yet. The tower has a buoyancy tank at its bottom and another in its fourth section (the tower may be made of any number up to six sections). It can be floated and towed to the location when by flooding the chambers it is made to sink and settle on the bottom of the sea for drilling. A. H. N.

**852. Problems Encountered in Drilling Abnormal Pressure Formations.** E. Cannon and R. S. Sullins. *Oil Gas J.*, 25.5.46, **45** (3), 120. *Paper Presented before A.P.I.*—The most important problem in connection with the drilling of abnormally high formation pressures is the prevention of lost returns. Methods that can be successfully employed in one area may not be applicable in another; however, several possible solutions to the problem are presented which are: (1) Careful control of the circulating rate. This also involves careful control of mud weight; (2) The use of very deep protective strings of casing; (3) Cementing zones of local weakness; (4) Use of sealing agents. Controlling the physical and chemical properties of a relatively high weight mud is complicated and more expensive than when dealing with normal mud weights. Methods are available for obtaining almost any desirable mud property. Careful planning of the mud programme and the use of every available means for conserving materials will result in a considerable reduction in mud costs, as well as more efficient operations. A. H. N.

**853. Improved Techniques and Methods in Controlled Directional Drilling.** G. Jackson. *Petrol. Engr*, May 1946, **17** (8), 84.—The two main reasons for drilling directionally are: (1) to reach oil in places difficult to reach vertically; and (2) to put out fires in oil wells by means of relief wells. Directional drilling was used extensively in Huntington Beach. Production figures of directional wells in this field during the years 1941–44, inclusive, are as follows:

| | |
|---|---|
| 1941 . . . . . | 4,329,359 brl |
| 1942 . . . . . | 4,500,870 „ |
| 1945 . . . . . | 5,389,934 „ |
| 1944 . . . . . | 9,026,794 „ |
| Total | 23,246,948 „ |

Among the applications of controlled directional drilling are: (1) deflecting from accessible locations to inaccessible locations; (2) deflecting around and under salt-dome overhangs that are difficult to drill through; (3) deflecting out of salt-dome cores to adjacent oil-sands; (4) deflecting relief wells into wild, burning, or cratered wells to bring them under control; (5) deflecting a hole from an unproductive to a productive portion of a lease; (6) deflecting an old depleted well to a new location in producing territory; (7) deflecting across faults or out of fault zones into a productive area; (8) deflecting a hold back into the lease after it has deviated over a lease line; (9) deflecting a plurality of wells from one location, or from a physically restricted area such as an island; (10) deflecting a series of holes for sub-surface geological exploration; (11) deflecting a hole so a sand can be cored after it was first drilled through without coring; (12) sidetracking fish or obstructions in the well; (13) deflecting a well back into a hole that has caved and was lost; and (14) deflecting off at an angle in oil formations to give greater penetration. The methods adopted are very briefly described. A. H. N.

**854. The Chemical Treatment of Drilling Fluids.** P. E. Chaney and W. F. Oxford, Jr. *Petrol. Engr*, June 1946, **17** (9), 158.—The chemistry of the colloidal systems of clay in water dispersions is discussed in some detail followed by a study of the effects of cement contamination of mud and the steps to be taken in curing the troubles. A long appendix gives in outline form mud troubles and their treatment.

A. H. N.

**855. Water-Base Mud Developments.** W. R. Kelley, T. F. Ham, and A. B. Dooley. *Oil Gas J.*, 11.5.46, **45** (1), 117. *Paper Presented before A.P.I.*—An abridged form is presented of a comprehensive review of water-base muds. The conclusions drawn are: (1) Laboratory data and scattered field evidence indicate that mud filtrates, mud cakes, and mud particles decrease optimum well productivity in varying degrees; (2) (*a*) By prudent application of the knowledge gained from accumulated data, operators are trying to reduce the detrimental effects of muds on the oil-zones. Where high formation pressures, high permeabilities, and low fluid viscosities are anticipated, efforts to achieve optimum productivity indices become less important; (*b*) The various muds described have important applications in the mechanics of drilling, casing, and completing wells. Long intervals of open hole, troublesome formations, low clearances for tools or casing, and long periods of suspended circulation require expert mud supervision; (3) Further laboratory and field experiments are justified on the basis of present information; (4) It is difficult in most cases to make good qualitative completion comparisons, and still more difficult to make quantitative studies because of varying individual well conditions, which may mask results of a specific procedure used; (5) There are many factors which need to be known in order to determine the effect of drilling fluids on productive intervals. Some are listed as follows: (*a*) Representative sand permeability data; (*b*) formation pressures; (*c*) viscosity of the oil in place; (*d*) gas–oil ratios; (*e*) water cut; (*f*) productivity index data over a period of time after well completion; (*g*) relative influence of mud filtrates, formation water, saline water, or fresh water on representative formation samples. Laboratory experiments on the effects of the various waters should duplicate field conditions as nearly as possible; (*h*) type and description of completion methods used; (*i*) degree of sand consolidation; (*j*) complete characteristics of the drilling fluid used; (*k*) length of time the productive interval is exposed to drilling fluid, and (*l*) completion date in relation to field history.

There is evidence to support the basic concepts presented in this paper. However, in many cases only inferences are possible. By drilling a carefully selected well with the best drilling fluid available and then killing the well with less desirable fluids, we should obtain results which would add materially to the knowledge of the reactions of a productive sand to the various types of muds and treatment. Pertinent data such as productivity indices could then be obtained at specific times after different fluids are employed in the well, leading to more quantitative conclusions on mud behaviour in well completions. A. H. N.

**856. Use of Oil-Base Mud at Elk Hills Naval Reserve No. 1.** R. W. Stuart. *Oil Gas J.*, 25.5.46, **45** (3), 128. *Paper Presented before A.P.I.*—It is believed that the use

of oil-base mud in these wells proved that this mud has a definite place in drilling, coring, and completing certain wells. During the drilling operations it is found that, with careful supervision, oil-base mud is no more trouble and does not present any greater problem than the use of natural mud in the same area. Oil-base mud in conjunction with certain plastic tracers soluble in oil but not in water, such as have been developed in Shell Oil Co. Inc., will probably give the most accurate core analysis date obtainable at the present time. In low-pressure, or low-permeability sands, and sands containing bentonitic material, the use of oil-base mud in completions will be a definite benefit. Although it was necessary to drill and complete the wells at Elk Hills during the war-time emergency in a minimum of time, and with a minimum of testing, it is believed that the core-analysis data obtained from these wells using oil-base mud made possible a more thorough and accurate knowledge if reserves and reservoir characteristics necessary for the best future reservoir control. Stanolind Oil & Gas Co's producing department has made a thorough study of oil-base mud drilling. A well in the North Katy field, Texas, has just been completed, coring through two oil-sands with oil-base mud. Electric logs were made by the two well-known services. Gamma ray and neutron logs were also run, both before and after cementing. Caliper logs and temperature surveys were made. The hole-caliper survey showed not more than 1-in. over gauge at any point and the various other logs correlated closely with the core data, to show formational breaks with a doubtful fluid definition. Some flushing was found in the cores, but the water saturation values determined by core analysis correlated surprisingly well with capillary pressure-saturation tests, indicating accurate connate water figures in the oil zone. A. H. N.

**857. Oil-Base Mud, Available in Forms which can be Built Up into a Wide Range of Specifications.** E. H. Short, Jr. *Oil Gas J.*, 1.6.46, **45** (4), 64–65.—The use of oil-base muds in the Gulf Coast area is briefly discussed. They are particularly useful in low-pressure completions where water-base muds would penetrate the pay formations. Sections of heaving shale have been drilled in a number of Gulf Coast wells with oil-base mud, and caliper surveys have shown that bit-sized holes were maintained throughout the sections. It is unnecessary to discard oil-base mud after being used in one well. It can be placed in a storage tank and used in drilling other wells. In some cases it may be necessary to change the character of the used mud to meet viscosity and weight requirements. Operators who have used oil-base mud state that it has remarkable qualities for jell forming which permits retention of cuttings.

Only a few extra equipment—*e.g.*, covered storage—are necessary. A. H. N.

**858. Varying Mud Power Pump Speeds.** G. C. MacDonald. *Oil Wkly*, 20.5.46, **121** (12), 44.—Normally the pump is connected to the internal-combustion engine through a single-speed transmission gear, and the only way of changing speed is to change that of the engine. Advantages of changing the speed of the pump without that of the engine are discussed, and cost reduction and other advantages accruing during drilling and coring operations when flexibility of mud velocity is allowed are illustrated. A. H. N.

**859. Casing Landing Practice.** J. B. Dettetre. *Petrol. World*, June 1946, **43** (6), 39–43. *Paper Presented before A.P.I.*—The advancement of casing programme design technique is pointed out in contrast to a lack of corresponding improvement in landing practice. It is suggested that individual attention be given to each well in a new field until enough information is available to warrant the adoption of standard procedure. Long oil strings and long intermediate protective strings are presented as being the most hazardous, and particular attention is directed to the necessity of keeping their landing weight to a minimum consistent with the other factors involved. Several common landing methods are discussed, showing their weaknesses under certain conditions. A chart is presented to show a method of determining the depth to the freeze point. Another chart shows a method of evaluating the effect on the load at the landing head of pressure and temperature changes. An example procedure is worked out to show the need of engineering consideration of the landing problem. The conclusion that the landing weight of long strings

should be held to a minimum is emphasized by reference to A.P.I. data on bi-axial loading which shows a substantial reduction of the resistance of casing to burst and collapse when tensile loads are more than half the yield strength of the pipe.
A. H. N.

**860. Deeper Completions Emphasize Need for Improved Casing-Landing Practices.** J. P. Dettetre. *Oil Gas J.*, 18.5.46, **45** (2), 139. *Paper Presented before A.P.I.*—The stresses imposed upon casings on landing are calculated and shown to be large in magnitude. An example is worked out to illustrate the methods of landing. It is noted that several operators have stated that they intend to install strain-gauges equipped with recording apparatus on the landing joint of casing so that data can be developed as to the actual variation of the load at the landing head. It is believed that an experiment of this type will bring to light reasons for some of the troubles that have occurred in casing after it has been landed. Reference to the data on biaxial loading in the A.P.I. paper on "Setting Depths for Casing" will show that large tensile loads have a substantial reducing effect on the resistance of casing to burst and collapse, especially when the tensile loads exceed 50% of the yield strength. Taking this into consideration, the reasons set forth in this paper for keeping the landing weight to a minimum without placing any pipe in compression take on added significance. A. H. N.

**861. New Multi-Stage Cementing Technique.** R. Sneddon. *Petrol. Engr*, June 1946, **17** (9), 152.—A multi-stage cementing operation is described in detail. Quantities, depths, pressures, and other data for the operation are given. A. H. N.

**862. Deep Test at Signal Hill.** N. A. D'Arcy, Jr. *Petrol. Engr*, May 1946, **17** (8), 74.—The equipment technique and results attained in the Shell well Alamitos 48 A, in its 14,950 ft depth, are given. Analysis is made of the drilling bits and of other data obtained in drilling. A. H. N.

## Production.

**863. The Relation between Well Spacing and Recovery.** W. V. Vietti, J. J. Mullane, O. F. Thornton, and A. F. Van Everdingen. *Oil Gas J.*, 1.6.46, **45** (4), 77. *Paper Presented before A.P.I.*—The authors conclude that no correlation exists between well spacing and recovery for the Mexia-Powell fault-line fields, and that recoveries obtained by open-flow production from areas within a reservoir cannot be used to derive or substantiate a mathematical relationship between spacing and recovery for the reservoir. There exists a difference of opinion as to the effect of spacing on recovery. Some authors contend that there is a mathematical relationship between the two. Such a relationship was recently proposed, based on recovery from the Mexia-Powell fault-line fields. A critical review of the information on these fields by the authors shows that the data cannot be used to derive such a formula. The differences in unit recoveries are small, and are attributable to factors other than spacing. Recoveries from areas of different spacing within a field heretofore have been used to derive or substantiate formulæ relating spacing and total recovery. This procedure is incorrect, as the difference in recovery exist because per well-producing rates are not related to the volume of pay or to the recoverable oil attributable to the well. The amount of the resulting drainage cannot be calculated easily, but in some cases may be approximated by assuming equal recovery/well. The choice of well locations (spacing) should be based on the principles which govern reservoir performance, and not on empirical formulæ proposed in the early days of the petroleum industry. A. H. N.

**864. Viscosity of Air, Water, Natural Gas, Crude Oil, and its Associated Gases at Oilfield Temperatures and Pressures.** C. Beal. *Petrol. Tech.* (A.I.M.M.E.), March 1946, **9** (2); Tech. Pub. No. 2018, 1–22.—The viscosity of oilfield fluids is of importance, since it controls the flow of the fluids in porous media and in pipes. Air is used in secondary recovery projects, and so must be included. The viscosity of gas-saturated crude at reservoir pressures and temperatures is of value in making estimates of oil reserves and rate of oil recovery from flush-pools when production decline data are limited.

Charts are presented for converting various viscometer units into centipoises, and there are graphical summaries of published data on the viscosity of air, water, and natural gas at high temperatures and pressures. As far as possible, the charts have been constructed to cover the ranges 60° to 300° F, and 14·7 lb/sq. in to 8000 lb/sq. in.

Bicher and Katz' correlation is presented for predicting the viscosity of natural gas with an average deviation of 5·8%.

Correlation charts have been constructed for predicting the viscosity of crudes under various conditions by employing 1215 viscosity observations from 836 crude samples taken in 630 fields, 459 of which were in U.S.A. and 75 in California. 786 values for gas-free crude were used; 351 were for gas-saturated crude and 78 for under-saturated crude. Results show that crude oil viscosity under various reservoir conditions can be predicted with average deviations ranging from 24·2% for gas-free crude to 2·7% for under-saturated crude above the bubble point. The viscosity of gas-saturated crude could be predicted with an average deviation of 13·4%, using only the viscosity of gas-free crude and the amount of gas in solution. The gas solubility in crude oil at various pressures, temperatures, and oil gravities can be estimated from a correlation of 351 viscosity observations, with an average deviation of 22%. The crude-oil viscosity at reservoir pressure and temperature may be predicted with a 19·8% deviation from a knowledge of the oil gravity, original gas/oil ratio, and reservoir pressure and temperature. This is within the accuracy of most reservoir computations. G. D. H.

**865. Vapour-Phase Equilibrium Cell Aids Condensate-Field Studies.** C. J. Deegan. *Oil Gas J.*, 18.5.46, **45** (2), 128.—Graphs are presented showing phase equilibrium data for condensate-field products, and a brief explanation of their use to predict the extent of production of the different components under varying reservoir conditions are presented. A. H. N.

**866. Well-Interference Effects.** Part 2. K. B. Barnes. *Oil Gas J.*, 20.4.46, **44** (50), 136.—For the purpose of assigning acreage and allowables for wells in Kansas interference tests were made. Also presented at the hearings were interference data of the "reverse-pattern type" taken by a major company in another producing area. Summaries of these tests, which altogether involve 83 wells in six producing areas, are given in diagram form in this article. The general procedure used was to shut in the pool, usually for 7 days, and during the shut-in period observe the rise in fluid levels of all wells in the selected area. Depths to the fluid level of each of the wells were obtained by sonic measurements at 72, 96, 120, and 168 hours after the field was shut in. The number of tubing collar reflections to the fluid-level point, in a measurement, were converted into the number of feet from the casing head to the fluid level. Correction for ground elevation was then made, to express the fluid levels as feet above a uniform subsea elevation across the producing area. At Boyd this subsea elevation was — 1475 ft, at Richardson — 1725, at South Silica — 1500. A centrally located well in the selected area then was pumped at a constant rate, usually for 5 days. While the pumping of the central well continued, fluid-level measurements of the wells were made at 24, 48, 72, 96, and 120 hours after pumping started. Fluid level in the producing well also was obtained at the same time. Each pool tested is briefly discussed. A. H. N.

**867. Well Interference and Reservoir Drainage.** Part 4. K. B. Barnes. *Oil Gas J.*, 18.5.46, **45** (2), 120 (this part concludes the series).—Previously established pressures are altered when fluid flow occurs within a productive area. This simple natural law is the basis of well-interference tests. A well is produced. If the pressure drops in adjacent wells, it is proof that there is continuous permeability and formational interconnection between the wells. More important, though, is the corollary that the pressure declines or interference data so established are prima facie evidence that oil present in the formation is flowing from the location of the one well to the other well. When flow occurs, drainage occurs. Such tests thus can help to prove or disprove whether drainage of the particular area can be accomplished—and by what wells and over what distances. Several well-interference tests in difficult fields are described. In some of the illustrations given, the data prove that continuous

permeability and formation interconnection exists for distances of 1, 2, 3, and even more miles. On the other hand, simply because these things have been found in certain pools is, of course, not evidence that faults, impermeable barriers, and formational discontinuities do not exist in some other pools, between comparatively short distances. For this very reason, interference tests are helpful tools to use in studying spacing and drainage problems. In these problems, if interference data show fluid flow to be possible over a certain distance, it would seem that reasons for advocating well spacings on lesser footages should be based on considerations other than those of fluid-flow relationships in the phyaical sense—and vice versa.

A. H. N.

**868. Unitized Portable Compressor Plant as Used for Pressure Maintenance.** F. L. Kallam. *Petrol. Engr*, May 1946, **17** (8), 70.—It is claimed that the present average cost of discovering, developing, and producing new reserves in the U.S.A. is greater than the selling price of the resulting new crude oil. Obviously, a barrel of extra oil, even at a relatively high production cost, is more profitable than that which may be discovered after a string of dry holes. Thus secondary recovery efforts to obtain additional oil from established reserves is of utmost importance. Probably the most important of all such methods are the gas-injection processes to formations where the primary recovery forces are fast being depleted. Other reasons are given for pressure maintenance. Unitized compressors are described in general terms and illustrations are presented. A. H. N.

**869. Selective Acidizing Increases Well Capacity.** P. L. Shelton and J. M. Clark. *Petrol. Engr*, May 1946, **17** (8), 235.—Recent potential tests conducted on several wells located in the Carthage gas-field of Panola County, Texas, have shown that selective acidizing of certain wells increases the total productivity as much as 50 to 75%. In the wells there are two distinct sections in addition to the regular pay section, and this fact presented difficulties in completion. Past experience had shown that treating individual sections by killing the well and mudding off each acidized section does not increase the total volume when the well is finally brought in for production. Once a section has been acidized and then mudded off, the effects of the treatment are reduced to such an extent that no material benefits are realized. Therefore a new technique was adopted. The well was completed so that each section with a definite break could be acidized and tested separately without killing the well. Two packers and two side-door chokes were used for this purpose. Thus each zone would be acidized separately and independently of the others by manipulating the chokes. Details are given of the method. A. H. N.

**870. Effect of Well Spacing on Water Flood Operations and Economics.** K. M. Fagin. *Petrol. Engr*, June 1946, **17** (9), 64.—The project of water flooding the Woodson field, Texas, is described in some detail. The geology and history of the sand are described, followed by a core analysis of the formation and of the probable reserves of the pool. Two schemes of well spacing have been adopted: The Tannehill sand was originally developed with oil-wells drilled 300 ft apart (one well to about two acres). The Davis flood was developed with new input water-wells drilled on 300-ft centres between the original wells. In this 2-acre flood pattern the input wells are abour 212 ft from the oil-wells. The Odell and Hughes flood, however, was developed, in general, by converting every other well to a water-input well, and resulted in having one water-input well to every 8 acres with the oil-producing wells situated either 300 or 424 ft from the input wells. The details of preparing the input wells are given. The David flood was begun in February 1941, with an average injection rate of about 40 brl/well/day. This rate was stepped up to 65 brl/well/day during the next 4 months, and reached a peak of about 100 brl/well 14 months after the beginning. The input rate was reduced gradually from this peak to the current rate of 45 brl/well/day. The Odell and Hughes flood has followed the same average input rate/well, but this flood is still at the peak rate of 90 to 100 brl/well/day, and the oil production is still at the peak. A. H. N.

**871. Producing Oil with Quantities of Water.** S. F. Shaw. *Petrol. Engr*, June 1946, **17** (9), 100.—The production of oil with a large proportion of water by means of

gas-lift is discussed in some detail. In order that an operator may arrive at some conclusion as to whether it would be profitable to instal a compressor plant for producing oil from wells making large quantities of water, it is desirable to ascertain conditions and trends that would lead towards a definite conclusion considerably in advance of the time when action must be taken. Data that should be observed while the well is flowing naturally are as follows: (1) Consideration of the size of casing, and its influence on the possible daily rate of liquid extraction; (2) Percentage of water accompanying the oil at different periods, and construction of graphs indicating the increase in percentage of water content in a given period of time; (3) Anticipate so far as possible the quantity of gas required to lift a barrel of liquid under given conditions of submergence, percentage of water, and quantity of liquid that will be lifted, when it becomes desirable to employ gas-lift; (4) Determine the manner in which disposal of salt water can be handled. The retention from abandonment of a well or wells down the flank of the structure should be considered; (5) Determine the cost of treating the fluid. It is usual, however, when producing large quantities of liquid with high percentage of water, that the temperature of the water is so high that treatment costs are quite low.

If the life of the plant, when employing gas-lift, promises to be more than 2 or 3 years, the possibility of building a plant to handle all the gas required should be given serious consideration; if the life is to be less than 2 years, it would probably be advisable to instal a plant of size sufficient only to maintain the input ratio at some figure below 10,000 cu ft/brl of oil. A. H. N.

**872. Paraffin Control of Pumping Wells by Hydraulic Power.** G. M. Wilson. *Oil Wkly*, 20.5.46, **121** (12), 36.—The process consists of pumping an oil-soluble plug through the tubing or production lead line. The plug, made of materials which cause it to dissolve after being submerged in oil for several hours, will retain its shape long enough to permit it to be pumped through the pipe, pushing accumulated paraffin ahead of it. It is designed to conform itself to abrupt changes in pipe direction. The equipment required is simple and inexpensive, operates easily, and has now been applied to a sufficiently large group of wells in diversified fields to determine its feasibility. In another application of fluid power, and utilizing the same power on the lease as used for plug type of cleaning, paraffin is quickly and easily scraped off the inside of the production tubing by hydraulically raising the inner string. Spring type scrapers, positioned at one-joint intervals on the inner string throughout the length of the paraffin zone interval, are pulled through the paraffin deposits, effectively scraping loose the material. Principal advantages of this new procedure are that paraffin control can be handled by the lease pumper merely by turning several valves, requiring no extra labour, or pulling equipment. A. H. N.

**873. Pumping Directionally Drilled Wells.** Anon. *Petrol. Engr*, June 1946, **17** (9), 230.—In a very short report it is stated that exceptionally good performance of sucker rods has been obtained on whipstocked wells. When directional drilling first made its appearance, 90 days was considered a reasonable length of time for sucker rods, and not more than 6 months for the life of tubing. Although the life of sucker rods and tubing is not definitely established under present operating conditions, it is a known fact that many wells will pump for months without the rods parting.
A. H. N.

**874. Internal Tubing Caliper Measures Extent amd Location of Corrosion.** P. E. Chaney. *Oil Gas J.*, 20.4.46, **44** (50), 115.—The Chaney-Barnes tubing caliper may be calibrated to measure the depth of corrosion pits, as well as the internal diameter of the tubing joint with an accuracy of $\pm$ 0·01 in. Three wells surveyed with the caliper have been worked over because of corrosion damage indicated by the caliper survey. A visual inspection of the tubing from these wells was in close agreement with the caliper survey record in each case. Calipering is accomplished by means of six or more independently operating lever arms, to the outer end of which are attached small wheels or rollers to contact the tubing wall. Each lever arm is provided with a spring to urge the feeler wheel outwardly against the tubing wall. The inner arms of the six levers contact a polished steel plate on the end of the stylus rod, and it may be seen that the stylus is driven downward whenever any one of the feeler

wheels moves outwardly into a pit. In event there are several pits of varying depth about a single cross-section of the tubing wall, the stylus will be actuated by the one feeler arm corresponding to the deepest penetration of the tubing wall and will be lifted free of the other five arms. The caliper might be considered pessimistic in this respect, as it shows the minimum wall thickness at any point traversed rather than the average wall thickness at that point. However, this is an advantage rather than a disadvantage, because the safety of the tubing with respect to pressure is determined by the minimum wall thickness, and not by the average wall thickness of the pipe. The instrument is accurately centred automatically. A. H. N.

**875. Sodium Chromate Effective in Combating Corrosion in Gas Wells.** C. K. Eilerts. *Oil Gas J.*, 18.5.46, **45** (2), 124. *Paper Presented before N.G.A.A.*—Sticks of sodium chromate dropped into a gas well subject to corrosion maintained inhibiting concentrations for more than 2 hours. The sticks can be injected into tubing against the fluid flow when the mean fluid velocity is not greater than 11 ft per second. Many improvements in the method are necessary before the treatment becomes practical. A. H. N.

**876. Plastics in Well-Remedial Work—How an Actual Job is Designed.** A. C. Polk, Jr., and D. F. Saurenman. *Oil Gas J.*, 18.5.46, **45** (2), 154.—Properties of the plastic used are given and a hypothetical—but typical—example is discussed to illustrate how a seal may be effected to isolate a producing horizon from the rest of the strata. A. H. N.

**877. Plastics Demonstrate Value in Plugging Back East Texas Wells.** G. Weber. *Oil Gas J.*, 8.6.46, **45** (5), 80.—Analyses are made of the types of East Texas wells which have been re-worked with the new plastics methods to shut off water. They show the results for the period 1943–46, and tell how the treatments are made. Methods of squeeze-setting blank and slotted liners with plastics are diagrammed. A. H. N.

**878. Oil-Pool Analyzer.** W. A. Bruce. *Oil Gas J.*, 11.5.46, **45** (1), 90–92.—An electric system which simulates the behaviour of oil wells in a reservoir is described. The basic theory of this analyzer rests upon: first, the analogy between the conductivity of an electrical conductor and the conductivity of a porous medium; and second, the analogy between the ability of a porous medium to produce stored fluid by virtue of the compressibility of the fluid and the ability of a condenser to release stored electrical charge. Although it is well known that petroleum reservoirs and the associated aquifers are characterized by lithological complexities, it has been found that local variations in the permeability and porosity of porous media average out in cases involving the movement of a large volume of fluid through a large cross section of porous stratum. It has been found that, with suitable adjustments of the analyzer, widespread variations can be taken care of in the analysis with accuracy comparable to the accuracy of the knowledge concerning these discontinuities. By setting the instrument to duplicate electrically the fluid behaviour in the past of the oil reservoir, future behaviour under different conditions can be predicted accurately. A. H. N.

**879. Trends in Processing Gas-Condensate Reservoirs.** F. H. Dotterweich and E. O. Bennett. *Oil Gas J.*, 11.5.46, **45** (1), 111. *Paper Presented before N.G.A.A.*—A tentative method to evaluate better retrograde losses occurring in condensate reservoirs are suggested showing trends which may make available, to post-war industry, a greater quantity of the lighter hydrocarbon fractions, by effecting greater economies in the extraction of these fractions from nature's reservoirs. It is shown that it is sometimes better not to recycle gas until a later date in the development of the reservoir and then to cycle back water gas. A remote possibility is suggested of using the reservoir as a reaction vessel to react the gases and produce other and more profitable materials in place. A. H. N.

**880. Method of Locating a Leak in Casing.** H. E. Gross. *Petrol. Engr*, May 1946, **17** (8), 93.—The principle involved in this method of locating a leak in a casing is

simply to determine the amount of water that is displaced in the annulus above the leak between the inner casing and the outer casing, or surface string. The method can be applied to wells that begin to leak between casing strings, but the position of leaks that occur elsewhere cannot be determined by this method. Coloured water is used to displace the clear water in the annulus. A. H. N.

**881. Proposed Design for Field-Testing Unit.** M. S. Watson, Jr. *Petrol. Engr*, June 1946, **17** (9), 84.—The factors involved in designing a vehicle carrying several instruments necessary for testing wells for productivity indices, pressures, bottom-hole samples, temperatures, tec., are discussed. A. H. N.

**882. Oficina Field is Scene of Venezuela's First Water-Flooding Experiment.** P. Reed. *Oil Gas J.*, 18.5.46, **45** (2), 137.—A brief description of water-injection plant is given. A. H. N.

**883. Drilling and Production Patents.** Erd. V. Crowell. U.S.P. 2,397,472, 2.4.46. Appl. 17.12.37. Oil well device.

Erd. V. Crowell. U.S.P. 2,397,473, 2.4.46. Appl. 15.11.38. Means for testing formations in wells.

William Edward O'Shei. U.S.P. 2,397,621, 2.4.46. Appl. 8.4.43. Fluid pressure motor.

Weyman B. Dunlap, Jr. U.S.P. 2,397,652, 2.4.46. Appl. 3.2.44. Underreamer.

Roy L. Luce, assr to Hydro Blast Corpn. U.S.P. 2,397,675, 2.4.46. Appl. 19.8.46. Sand slurry valve.

Ira T. Minyard. U.S.P. 2,397,679, 2.4.46. Appl. 12.3.45. Paraffin scraper.

Ruben Hadekel, assr to Aeronautical & Mechanical Investments, Ltd. U.S.P. 2,397,763, 2.4.46. Appl. 30.11.43. Hydraulic control system.

Fred. E. Cooper. U.S.P. 2,397,778, 2.4.46. Appl. 14.4.44. Fluid-pressure motor.

Walter R. Freeman, assr to Wagner Electric Corpn. U.S.P. 2,398,090, 9.4.46. Appl. 21.5.43. Oil separator.

Wesley H. Sowers, assr to The Pure Oil Co. U.S.P. 2,398,123, 9.4.46. Appl. 8.1.42. Control of pH of water from earth bores.

De Witt C. Stowe. U.S.P. 2,398,124, 9.4.46. Appl. 23.10.44. Hydraulic transmission.

George Henry Walker, assr to Heenan & Froude, Ltd. U.S.P. 2,398,167, 9.4.46. Appl. 25.10.44. Transmission dynamometer.

Rudolph C. Buchan, assr to Standard Oil Development Co. U.S.P. 2,398,204. 9.4.46. Appl. 21.9.40. Method and apparatus for handling oilfield emulsions.

Samuel R. Kassouf. U.S.P. 2,398,229, 9.4.46. Appl. 16.8.43. Fluid pressure-operated servo-motor.

Dixon T. Harbison. U.S.P. 2,398,305, 9.4.46. Appl. 20.9.45. Valve puller.

Aage Jensen. U.S.P. 2,398,313, 9.4.46. Appl. 15.5.42. Hydraulic transmission.

Bruno Pontecorvo, assr to Well Surveys. U.S.P. 2,398,323, 9.4.46. Appl. 10.8.43. Well surveying.

Jay P. Walker, assr of 40% to Guy O. Marchant and 6% to C. G. Wells. U.S.P. 2,398,338, 9.4.46. Appl. 1.8.40. Combination heater and water knockout apparatus for treating oil well streams.

Francis M. Anderson, assr to Halliburton Oil Well Cementing Co. U.S.P. 2,398,347, 16.4.46. Appl. 17.6.44. Material for sealing off porous formations in wells.

Herbert E. Page. U.S.P. 2,398,392, 16.4.46. Appl. 22.1.45. Hydraulic torque wrench.

Millard E. Alexander. U.S.P. 2,398,399, 16.4.46. Appl. 3.2.43. Pipe joint.

Nicholas Bell. U.S.P. 2,398,491, 16.4.46. Appl. 18.12.42. Boring head.

Jens. A. Paasche. U.S.P. 2,398,503, 16.4.46. Appl. 20.2.43. Fluid pressure regulator.

Thomas H. Berry, assr to Green & Berry Farm Equipment Co. U.S.P. 2,398,512, 16.4.46. Appl. 27.9.43. Well drilling machine.

Cicero C. Brown and Floyd L. Scott, Jr., assr to Brown Oil Tools. U.S.P. 2,398,515, 16.4.46. Appl. 15.10.43. Washover overshot.

William E. Halbert. U.S.P. 2,398,527, 16.4.46. Appl. 6.4.44. Means for flowing wells.

William L. Russel. U.S.P. 2,398,562, 16.4.46. Appl. 28.12.44. Apparatus for well logging.

Francis W. Crawford, assr to Phillips Petroleum Co. U.S.P. 2,398,580, 16.4.46. Appl. 17.6.40. Method of prospecting for hydrocarbons.

George L. Matson, assr to The Dow Chemical Co. U.S.P. 2,398,752, 16.4.46. Appl. 7.4.45. Dumping bailer.

Charles B. Aiken, assr to Schlumberger Well Surveying Corpn. U.S.P. 2,398,761, 23.4.46. Appl. 30.11.40. Method and apparatus for simultaneous determination of various properties of the subsoil.

John W. Millington, assr to Sperry-Sun Well Surveying Co. U.S.P. 2,398,800, 23.4.46. Appl. 6.7.40. Electrical prospecting method and apparatus.

Thomas F. Stacy, assr to the French Oil Mill Machinery Co. U.S.P. 2,398,811, 23.4.46. Appl. 20.9.41. Controlling valve for hydraulic motors.

William A. Ray, assr to General Controls Co. U.S.P. 2,398,855, 23.4.46. Appl. 27.1.41. Fluid control valve.

Robert W. Stuart and Daniel Silverman, assr to Stanolind Oil and Gas Co. U.S.P. 2,398,868, 23.4.46. Appl. 26.6.43. Apparatus for electrical well logging.

Donald G. C. Hare, assr to The Texas Co. U.S.P. 2,398,934, 23.4.46. Appl. 27.9.41. Gamma radiation detector.

Fred S. Carver. U.S.P. 2,399,102, 23.4.46. Appl. 4.3.43. Valve for controlling high-pressure fluids.

Philip J. Lehnhard, Jr., assr to The Dow Chemical Co. U.S.P. 2,399,125, 23.4.46. Appl. 21.7.39. Well packer.

Clyde O. Davis and Lawton A. Burrows, assr to E. I. du Pont de Nemours & Co. U.S.P. 2,399,211, 30.4.46. Appl. 19.3.42. Method of perforating well casings.

William R. Ray, assr to General Controls Co. U.S.P. 2,399,294, 30.4.46. Appl. 10.11.41. Hydraulic operator.

Cecil V. Augustine. U.S.P. 2,399,312, 30.4.46. Appl. 16.4.45. Coupling sleeve puller.

Claude W. Metzger and Paul R. Snetcher, assr to Haynes Stellite Co. U.S.P. 2,399,372, 30.4.46. Appl. 11.5.43. Rotary cutting tool.

Edward Dodson, U.S.P. 2,399,474, 30.4.46. Appl. 22.4.44. Hydraulic servomotor.

Warren R. Tucker, assr to The Hydraulic Development Corpn. U.S.P. 2,399,520, 30.4.46. Appl. 9.2.42. Hydraulic system.

William T. Livermore. U.S.P. 2,399,554, 30.4.46. Appl. 24.12.37. Transmission and fluid pressure clutch mechanism therefor.

Carl W. Mott, assr to International Harvester Co. U.S.P. 2,399,756, 7.5.46. Appl. 31.12.43. Fluid control for fluid-driven motors.

Wendell B. Steward, assr to Schlumberger Well Surveying Corpn. U.S.P. 2,399,766, 7.5.46. Appl. 10.12.42. Bridging plug for use in boreholes.

Dwight M. Phillips, assr to Chiksan Tool Co. U.S.P. 2,399,823, 7.5.46. Appl. 21.4.42. Swivel joint.

Otto P. Warner. U.S.P. 2,399,842, 7.5.46. Appl. 18.12.40. Separator.

William W. Alkire. U.S.P. 2,399,844, 7.5.46. Appl. 4.4.45. Combined bailer and dump.

Thomas S. Chapman, assr to Standard Oil Development Co. U.S.P. 2,399,986, 7.5.46. Appl. 9.7.45. Drilling method and fluid for use therein.

Fred E. Hummel, assr to Shell Development Co. U.S.P. 2,400,046, 7.5.46. Appl. 22.2.44. Mud logging system.

R. B. S.

## Oilfield Development.

**884. Annual and Cumulative Production; Remaining Reserves by Fields.** Anon. *Oil Gas J.*, 26.1.46, **44** (26), 202.—The 1945 production, the cumulative production to the beginning of 1946, the estimated reserves at the beginning of 1946, and the number of wells are given for the leading fields in the various states and areas of U.S.A. G. D. H.

**885. Exploratory and Development Drilling—Where it Occurred and the Results.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 233.—A series of tables give the completion results for wildcat and development wells in U.S.A. in 1945, by fields in the various states, with summaries of the monthly completion results by states. G. D. H.

**886. Discoveries.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 176.—In 1945 wildcat tests in U.S.A. increased sharply in number, but from the point of view of new reserves discovered they were not impressive. Normally, however, it takes about two years from the time a new field is discovered before any substantial daily output is developed. Texas had 40% of the total wildcatting. Wyoming showed a greater increase in wildcatting in 1944 and 1945 than any other State.

Diagrams show the numbers of oil, gas, and condensate fields discovered yearly from 1933 for the South Arkansas–Louisiana–Gulf Coast Plain area, with the average well depth each year from 1937. The oil, gas, and dry wells are shown diagrammatically for U.S.A. as a whole for 1942 onwards, with similar data for the more important States. G. D. H.

**887. Production.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 168.—U.S.A. produced 1,711,000,000 brl of oil in 1945, about 32,000,000 brl more than in 1944. The peak daily output was nearly 5,000,000 brl in August, after which there was a decline to about 4,500,000 brl/day.

Texas was the chief producer, with more than twice the output of California, which was second. Oklahoma was third and Louisiana fourth.

The production is given by States each year from 1939 onwards, while diagrams show the production and reserves each year from 1943 for the leading States, with similar diagrams for the production of the world, the Caribbean region, and the Middle East.

Notes are given on the 1945 production of the leading fields in the more important areas of U.S.A. G. D. H.

**888. Reserves.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 176.—Although the big exploration programme of 1945 failed to give outstanding discoveries, 2,275,000,000 brl of oil was found. It has been estimated that in the period 1944–1950 2,000,000,000 brl of oil should be found each year to satisfy demands; 1945 exceeded this figure. In future years, with fewer handicaps, this figure should be exceeded by an even greater margin.

Texas, California, Louisiana, Oklahoma, and Kansas are the leading States from the point of view of reserves. Together with the Rocky Mountain States, these five possessed 91·4% of the 1945 reserves. Texas has over half of the total U.S. reserves.

A table gives the U.S.A. reserves by States and districts, the figures being for the beginning and end of 1945, with the amounts added by 1945 discoveries, and extensions and revisions. G. D. H.

**889. New Reserves.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 187.—More than 400 new pools were found in U.S.A. in 1945, and extensions were made to 100 fields. 94

new gas reservoirs were found, while 16 were extended. Texas had 138 new oil discoveries, 40 new pay discoveries, and 55 extensions. Texas also had 36 new gas-field discoveries.

The 1945 discoveries, whether new fields, new pays, or extensions, are listed by States, with the name, location, producing formation, proven acreage, formation thickness, and estimated reserves. Maps show the sites of the new discoveries.

G. D. H.

**890. Drilling and Completions.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 159.—26,879 wells were completed in U.S.A. in 1945; the 1946 programme calls for 23,171 wells. 4256 wildcats were drilled in 1945, and 4442 are expected to be drilled in 1946. Texas has 7195 completions in 1945.

More wells are expected to be drilled in Mississippi, Alabama, Colorado, and Wyoming than in 1945; but in the Mid-Continent area the reverse is expected to be the case.

Tables give by States and districts the following data: the total field wells and wildcat wells drilled in 1945 and those planned for 1946, with the former subdivided according as they were cable or rotary wells; the status of development and wildcat completions in 1945; a comparison of the completion results for certain States in 1944 and 1945. Short notes are given on the various areas. G. D. H.

**891. Summary of December Completions.** Anon. *Oil Gas J.*, 26.1.46, **44** (36), 211.—During the five weeks ended December 29, 1945, 2426 wells were completed in U.S.A. 1330 found oil and 25 found gas. The completion results are summarized by States and districts, and the numbers of wells in different depth ranges are given.

G. D. H.

**892. February Completions Gain.** Anon. *Oil Wkly*, 18.3.46, **121** (3), 63.—Completions in U.S.A. in February 1946 averaged 493 per week. During the first two months of 1946 the completion rate was 13·1% above the figure for the first two months of 1945. 1118 of the February completions found oil, and 189 found gas.

A table summarizes the February completion results by States and districts.

G. D. H.

**893. Rangely Field Largest Addition to Reserves in 1945.** F. N. Bosco and J. D. Brawner. *Oil Wkly*, 25.2.46, **120** (13), 18.—The Rangely Field of Colorado is on the White River about 15 miles east of the Utah boundary. Oil seeps occur on the Rangely dome, and in 1902 a well was drilled into the productive portion of the Mancos shale, finding oil at 800 ft and at 1700 ft. The output was small. Other Mancos shale wells were drilled, and a number of wells were drilled to the base of the Dakota sandstone which proved gas-bearing. In 1933 a 7173-ft well found gas in a thin Morrison sand, and oil in the Pennsylvanian Weber sand. The well was shut in until 1943, and when reopened flowed 225 brl/day. Development of the Pennsylvanian oil began in 1944.

The Rangely dome is asymmetrical, with the southwest flank dipping at about 6°. Northeasterly-trending faults cross the axis. Fractures in the Mancos shale provide the shallow production. Oil is found in the Mancos shale, gas in the Dakota sandstone, oil and gas in the Morrison lenticular sandstones and in the Weber sandstone. Deeper horizons have not been tested, but the Leadville limestone (Mississippian) and the contact of the sediments and basement have possibilities. (In the Oregon basin, Wyoming, oil has recently been found in the Cambrian Deadwood sandstone overlying the granite.)

It is believed that in order to obtain production in the Mancos shale a fracture zone must be penetrated. The paraffinic oil may be indigenous to the formation. These wells are cheap to drill. The oil has very little gas.

The Weber sandstone is about 1200 ft thick. The upper 300 ft is very fine-grained; the next 300 ft has red argillaceous sandstone interbedded with white dolomitic sandstones and then oil-stained sandstones. The rest is non-productive. The Weber oil zones total about 125 ft, and are irregular. The best production is obtained in the north. The 33–35° oil has 300–350 cu. ft gas/brl. Bottom-hole pressures are about 2200 lb/sq. in. Weber sand wells are nearly 6000 ft deep, and cost about $20/ft.

In December 1945 there were 29 Weber sand producing wells, the output being 11,300 brl/day. The extent of the productive area is undetermined, but is estimated at 13,440 acres, giving a reserve of 1176 million brl in place with an expected recovery, by primary methods, of 400 million brl.

A stratigraphic column, stratum contour map, and a forecast of future production are included. G. D. H.

**894. Discoveries and Development of West Texas Pre-Permian Reaching Major Proportions.** C. J. Deegan. *Oil Gas J.*, 23.2.46, **44** (42), 139.—By the beginning of 1946 about 38 new pre-Permian fields had been discovered in West Texas and southeast New Mexico, and, counting multiple pays, there are some 54 pools. During 1945 the bulk of the development drilling was in the Keystone, TXL, Todd Deep, and Fullerton fields.

The first pre-Permian discovery was at Big Lake in Reagan County in 1928, when production was found in the Pennsylvanian and Ellenburger. In 1936 Simpson production was found at Sand Hills, and in 1939 Ellenburger production at Apco-Warner. Accelerated development began in 1940 at Sand Hills (Ellenburger), Todd Deep (probably Strawn), Abell (Simpson), and Shipley-Silurian (Silurian). 1941 yielded Sand Hills (Ellenburger and Simpson), Heiner (Ellenburger), Wertz (Ellenburger and perhaps Cambrian), and Barnhart (Ellenburger). A number of discoveries were made in 1942, and fewer in 1943. During 1944 Ellenburger oil was found in New Mexico. Devonian production was obtained at Todd Deep and TXL. 20 new pools in 12 new fields were discovered in 1945, and these included Devonian discoveries at Three Bar, Dollar Hide, and Bedford.

The depth to the various pre-Permian beds increases sharply from south to north along the Pecos County–Andrews County trend. This is controlled by the Central Basin Platform. Deep structure is not necessarily revealed by the Permian beds.

The pre-Permian pools of West Texas and southeast New Mexico as of January 1, 1945, are listed with the discovery date, oil gravity, approximate depth, and producing formation.

Four maps are included. G. D. H.

**895. Caribbean and Middle East Enlarge Stature as Oil Sources.** W. W. Burns. *Oil Gas J.*, 26.1.46, **44** (36), 276.—W. A. Sinsheimer has predicted the U.S.A. crude supply as 4350 thousands of brl/day each year for 1946, 1947, 1948, and 1949, with the corresponding demand respectively 4230, 4520, 4800, and 5130 thousand brl/day.

A table gives the estimated crude oil production in 1944 and 1945 for Venezuela, Colombia, Trinidad, Mexico, Argentina, Peru, and the rest of South America, Canada, Iraq, Iran, Egypt, Bahrein and Arabia, Kuwait and India. The first three countries are estimated to have produced 1,000,000 brl/day in 1945, the last six 550,000 brl/day, and the remainder 1,254,300 brl/day. G. D. H.

**896. Bolivian Production Rises to 39,411 Brl in August.** Anon. *Oil Gas J.*, 23.2.46, **44** (42), 119.—Bolivia's August 1945 production of 1271 brl/day was 7% above the July figure. G. D. H.

**897. Guarico's 1946 Exploration Programme is Most Extensive in Venezuela.** P. Reed. *Oil Gas J.*, 16.3.46, **44** (45), 66.—The reserves of Eastern Venezuela, where Monagas and Anzoategui have the main producing fields, are estimated to be 1,500,000,000 brl.

More than half of the exploration concessions in Eastern Venezuela are in Guarico. Drilling to the Cretaceous in earlier wildcatting along the "tar shelf" has led to renunciation of some concessions in the southeast. Programmes call for the operation of 16–18 rigs. Camps and roads account for a budget exceeding $10,000,000. S. A. Petrolera Las Mercedes has 179,000 hectares of exploration concessions and 348,000 hectares of exploitation concessions. 20 producers and 3 dry holes have been completed in the Las Mercedes field. Sands are lenticular and faulted, with gas in the crestal regions. Production is from 3 La Pascua (Miocene) sands 4000–4400 ft deep. The oil is about 32° A.P.I. gravity. 26° A.P.I. oil has been found in the Cretaceous in one well. Wildcatting is proceeding in the Punzon-Grico area to the west and in the Camaz-Placer area to the northwest.

Guarico lies in part of Venezuela's largest geosyncline which is filled with Cretaceous

and Tertiary beds. It includes a series of basins which advanced southwards during the Tertiary and Quaternary. Sedimentation was reduced or interrupted in the Middle Eocene, and land barriers are believed to have existed in the north. In the Oligocene there were saline-estuarine conditions in certain basins, but there were marine invasions. Conditions began to change in the Middle Miocene or later, and there was retreat of the sea and deposition of lignites. G. D. H.

**898. Anglo-American Oil Co.'s Search for Oil in Britain.** *Petrol. Times*, 25.5.46, **50** (1,271), 526–528.—The activities of Anglo-American Oil Co. in Southern England and other parts of Britain in the search for oil are described, particularly the drilling of the well Gringley No. 1. A. H. N.

**899. Oilfield, Coevorden-East.** K. H. R. Hoyer and E. L. Siccama. *Ingenieur*, 1946, **58**, A.61–67.—A description of the Coevorden East oilfield in Holland. Discovered between 1937 and 1939, the field is geologically related with the German Emlichheim area. Intensive exploration by the Bataafsche Petroleum Mij began towards the end of 1941. In July 1943 the first oil was produced at a rate of 1 cu. m. per day.

Production : 1943— 233 cu. m.
1944—1946 cu. m.
1945—6479 cu. m.

The viscous paraffinic crude (d. 15 : 0·905) has a high pour point and contains very little light components. M. B.

**900. French Production.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—In September, 1945, Pechelbronn was producing 925 brl/day. A year earlier the figure was 1250 brl/day. G. D. H.

**901. Production Gradually Gaining in France.** Anon. *Oil Gas J.*, 9.3.46, **44** (44), 51.—In 1939 500,000 brl of crude from Pechelbronn was processed. In March 1945 the field was recovered from the Germans, and in September the production was 925 brl.

Exploitation began in 1735, and the cumulative production exceeds 18,500,000 brl, about 5,300,000 brl being from shafts and galleries. 5000 wells have been drilled, with a total footage of 6,233,000 ft. G. D. H.

**902. German Oilfields To-day.** Anon. *Petrol. Times*, 25.5.46, **50** (1274), 529–530.—A brief outline of the geology and potentialities of German oilfields is given. It is stated that practically all of the reserves have been used during the war, that exploration was stopped, reserves used up uneconomically, and that when new fields were found it was too late to affect output. Perhaps the most interesting feature, however, is the revelation for the first time that the Control Commission's policy is not only to encourage maximum economic production of crude, but also to prosecute to the full the search for new German oil resources. A. H. N.

**903. Russia's Reserves Largest in World, Official Claims.** Anon. *Oil Wkly*, 18.8.46, **121** (3), 68.—It has been stated that 34 new sources of oil were discovered in the U.S.S.R. during the war, compared with 83 in the previous 20 years. New areas were being developed in Daghestan, central Asia, Sakhalin, and east of the Volga. G. D. H.

**904. "Second Baku" may Surpass First Field in Importance.** Anon. *Oil Wkly*, 18.3.46, **121** (3), 68.—The "Second Baku" is in Bashkiria, and is now 14 years old. Seven Fields are being exploited. In 1944 oil was found in the Devonian near Tuimazy. G. D. H.

**905. Iranian Production Setting New Record.** Anon. *Oil Gas J.*, 16.3.46, **44** (45), 65.—In the first nine months of 1945 Iran produced 95,421,032 brl of oil; in the whole of 1944 the output was 92,919,701 brl. During the same period Anglo-Iranian Oil Co.'s production in Britain was 463,141 brl, the 1944 figure being 641,990 brl. G. D. H.

**906. Production in Punjab Continues to Decline.** Anon. *Oil Gas J.*, 23.3.46, **44** (46), 64.—In 1945 the Punjab fields produced about 350,000 brl of oil. The output in 1941, the peak year, was 886,000 brl. G. D. H.

## Transport and Storage.

**907. Submarine Loading Line Replacement.** R. P. Howell. *Oil Gas J.*, 27.4.46, **44** (51), 108.—An account is given of the replacement of the 3700-ft light oil submarine line at El Segundo refinery, south of Los Angeles.

The original line was laid in 1934, and consisted of $\frac{1}{2}$-inch wall, $1\frac{3}{4}$-inch o.d. well casing. Cathodic protection was applied in 1938, but inspection in 1944 showed severe internal corrosion, necessitating replacement. To minimize effects of internal corrosion, $\frac{3}{4}$-inch concrete-lined 14-inch o.d. pipe in 30 ft lengths, was chosen, weighing 73 lb/ft, and having expanded end joints. It was laid in two straight courses with one angle point after locating electronically the exact lie of the existing lines. Sections were welded and launched after the cooling water was removed, and the flanged ends sealed with plate closures. The pipe landed evenly and with little shock, provided an even fall was arranged. Three 1000-lb.-capacity lifting buoys were used to again raise the sections nearer the surface; these were then towed out to the correct positions, where they were lowered as directed by the diver, and guided into position.

Bolting was done by the diver using an air-operated wrench. After final tightening of joints, the line was successfully tested at 450 p.s.i. G. A. C.

**908. Calculation of Throughput (when Several Liquids Flow Simultaneously Through a Pipeline).** B. Miller. *Oil Gas J.*, 2.3.46, **44** (43), 64.—As an illustration of the problem with which the author is dealing he considers a 20-inch line transporting simultaneously propane, light gasoline, heavy gasoline, and kerosine. The line is 100 miles long and contains 50,000 brl each of propane and the two gasolines, the balance being kerosine. Knowing the specific gravity and viscosity of these products, pipeline efficiency, and pressures, the author shows how the throughput can be calculated. D. L. S.

**909. Tripling Westward Flow of Iraq Oil.** *World Petrol.*, 1946, **17** (4), 40–42.—Details are presented of Iraq Petroleum's Co. proposed new 16-inch lines to Haifa and Tripoli. The economic and financial reasons for construction are given. Accumulation of material has commenced, but laying is not due to start until October, 1946. New refineries are forecast at Haifa and Tripoli. Statistics are given supporting the view that the new pipeline is an economic proposition from the crude supply standpoint. When new lines are in operation 13,000,000 tons can be handled annually. F. S. A.

**910. Storage of Volatile Petroleum Products.** H. C. Boardman. *Refiner*, 1946, **25** (4), 109–116.—For both crude oil and gasoline in storage the vapour pressure is not only a function of temperature, but also, to some degree, of the size of the vapour space. Evaporation losses from volatile liquids in storage vessels may be prevented or reduced by (*a*) allowing changes of volume at constant or variable pressure (breather, balloon or lifter roofs); (*b*) allowing no vapour space (floating roofs or water displacement); (*c*) withstanding the combined liquid and vapour space pressures (spheroids spheres); (*d*) resisting both the maximum internal pressure and the maximum internal vacuum (spheres); (*e*) insulating the tank from the heat of the sun; (*f*) cooling, refrigerating, and vapour-recovery systems; and (*g*) any combination of the above. It is believed there is a trend towards (1) A greater utilization of complete or partial vacuum, complementary to pressure in reducing or preventing filling and storage losses. (2) Exclusion from the storage space of all air except that entrained by the entering liquid. (3) Installation of chemically inert flexible fabric hinges in low pressure devices such as breather and balloon roofs at connections subject to flexure. (4) Storage in large quantities of highly volatile products such as propane.

G. R. N.

**911. Rock Tanks for Oil Storage.** Anon. *Engineer*, 1946, **181**, 505.—Oil storage at a large base station of the U.S. Navy is provided by tanks excavated in the solid

rock. The tanks are vertical cylinders with hemispherical ends, the rock being lined with 3 ft of concrete on the sides and 8 ft at top and bottom; there is also an all-welded steel lining inside the concrete. There are 20 tanks in two parallel rows, spaced 200 ft in each direction. The internal dimensions of each tank are 100 ft dia by 250 ft high. The tanks are connected by a series of tunnels which accommodate the piping system and which served to remove material during excavations. The tunnels are fitted with automatically closing doors in concrete bulkheads, so as to prevent flooding of the tunnels in case of a break or leak. A. C.

**912. Plastic Tank Coatings Resist Sour West Texas Crude Corrosion.** G. Weber. *Oil Gas J.*, 29.6.46, **45** (8), 89.—A description is given of the trials made on steel tanks and tubes protected by a coating of "Resoweld," under extreme corrosion conditions for periods up to two years. Resoweld is a liquid thermoplastic resin, which was developed during the war by the Goodyear Tire and Rubber Co., which, when applied under the conditions described, forms a firmly bonded coating on metal, cement, or wood which is flexible enough to withstand (1) bending at 100° F, without chipping, (2) rupture by movement or blows. It is highly resistant to a variety o acids, including $H_2S$, bases or salts in aqueous solution and aliphatic hydrocarbons, it softens in aromatic hydrocarbons and chlorinated solvents, and is soluble in ketones. As a non-conductor of electricity, it arrests electrolytic corrosion in tanks, etc., and also stops bacterial action. The method of its application is described, the main step of which is the preparation of the metal surface to be coated. New metal is cleaned and sandblasted. Used tanks are cleaned, brushed, scraped, aired two days, and sandblasted twice before the application. The tests were made by the use of a crude oil from the Penwell field, Ector County, West Texas, this crude being widely considered to be one of the most corrosive crude oils; it contains approximately 10% salt water and has a high sulphur content. Resoweld has given highly satisfactory protection against corrosion. W. H. C.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**913. Steam and Power Generation in the American Refinery (Part I).** W. F. Ryan. *Oil Gas J.*, 29.6.46, **45** (8), 78.—In a study of the steam and power generation of U.S. refineries, it is observed that despite the development progress in general refinery engineering and process technology, generally speaking, the organizations have neglected the economic advantages obtainable from the use of high-pressure generation of steam and its application to electric power generation, as adopted by the electric power industry, yet it is well known that high-pressure steam, with its high temperature, yields vastly greater returns in refineries than in the electric power industry, which since 1926 has employed steam pressures up to 1200 p.s.i. with temperatures of 900–950° F. As heavy consumers of steam with moderately heavy demands for electric power, refineries now, with their extensions of activities into the petrochemical field, have become heavy consumers of both, requiring 1,000,000 lb/hr and more of steam, and electric power exceeding 25,000 kw.

Up to 1925 it is shown that steam-raising plant for refineries was designed for pressures of 150–200 p.s.i., the highest being 275 p.s.i., whereas steam pressures employed by electric power concerns rose mainly to around 400 p.s.i. with temperatures of 700° F, though three concerns used 600 p.s.i. at 750° F, and one electric supply used steam at 1200 p.s.i. at the same temperature. In a central power-station with turbines using steam at 750° F (considered the highest practical temperature in 1925), and exhausting at an absolute pressure of 1 inch Hg., the energy theoretically available from the steam is increased less than 7% by increasing the throttle pressure from 400 to 1200 p.s.i.g. For an industrial plant turbine exhausting at 150 p.s.i.g., the corresponding gain in available energy is 44%. The first high-pressure industrial steam power plant was started in 1927 and was designed for 900 p.s.i. at 750° F. In 1935 there were 85 industrial power plants of this class, including 8 at refineries. Of these 8, the first was built for the Gulf Oil Co. refinery at Port Arthur in 1929, which was designed for 525 p.s.i. at 635° F to operate one

turbine generator to produce 10,000 kw. and exhausted at 125–150 p.s.i. to the refinery mains; its output of steam and electricity are given. The slow-growth of high-pressure steam installations at refineries over the next 10 years is discussed. Steam pressures employed rose to 550–650 p.s.i. at 700–750° F, one installation only was designed for operating at 835 p.s.i. and another for working at 600 p.s.i. at 800° F. The steam and turbine electric units erected in 1936 at the Standard Oil Co.'s Richmond refinery produced 4000 kw. in each of three turbines using steam from three boilers at 838 p.s.i. at 750° F, and exhausting at 150 p.s.i. The installation is briefly described. At this date (1936) power concerns were using steam at 850–900° F. The Richmond installation represents the highest pressure pre-war design for refinery production of steam. Further details are given in respect to refinery economics, set-up and auxiliaries—*e.g.*, water-softening plant. W. H. C.

**914. Heat Transfer and Friction of Water in an Annular Space.** F. G. Carpenter, A. P. Colburn, E. M. Schoenborn, and A. Wurster. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 165.—Uncertainties existing in means for predicting heat transfer coefficients of fluids flowing in annular spaces, especially in the region of transition from viscous to turbulent flow, led to an experimental study of water flowing upwards in a narrow annular space. This paper presents data for heat-transfer and isothermal pressure drop for water flowing in the annulus formed between $\frac{3}{4}$ inch O.D. and 0·834 inch I.D. copper tubes 8 ft long and arranged in a vertical position. Hot water, circulating at constant high velocity through the inner tube, was the heating medium. Surface coefficients of heat transfer between the inner tube and the annular fluid were determined by subtracting from the overall resistance to heat transfer the sum of the resistances due to the inner water, the metal wall, and any possible dirt or scale.

The friction date, shown by Fig. 7, indicate that the proper choice of diameter to be employed in evaluating Reynolds numbers is the equivalent diameter, $D_e = D_2 - D_1$, since with Reynolds numbers so calculated the transition from viscous to turbulent flow occurs at approximately 2000, similar to flow inside tubes. In the viscous region the values of friction factor are in excellent agreement with the theoretical relation; this agreement lends confidence to the techniques and measurements employed in this study. Data in the turbulent region fall on the literature line for commercial pipe.

The heat-transfer data, shown on Figs. 8, 9, and 10, cover a range of Reynolds number, based on equivalent diameter, from 150 to 15,000. At highest Reynolds numbers the data approach correlation of results for circular tubes. At lower Reynolds numbers the annular data fall somewhat under circular tube results. In the viscous region, where little previous data on annuli exist, the results are shown to be slightly higher than relations for flow inside tubes. A. R. J.

**915. Cottrell Electrical Precipitation Equipment, Some Technical and Engineering Features, Recent Developments, and Application in the Chemical Field.** C. E. Beaver. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 251.—Fundamentally the principle of the Cottrell precipitator is substantially the same to-day as that established by Dr. Cottrell a number of years ago. There have been, however, a number of marked changes in technical and engineering features, as well as new developments and improvements in order to meet the requirements of modern industrial application.

The present paper discusses in general the equipment required, the various types of precipitators for specific applications, and the different factors which enter into the design of a modern Cottrell installation. The variables influencing the rate of precipitation or efficiency of removal are also presented, with particular reference to gas velocity, time of treatment, current flow, and surface conductivity of the suspended particles.

A number of the more recent developments of a technical and engineering nature are given, and the various applications of the Cottrell equipment in the chemical field are discussed with specific mention of the application in the phosphorus, pulp and paper, carbon black and petroleum industries, including its use in the fluid catalytic cracking process. A. R. J.

**916. Synthetic Rubber and Plastics as Materials of Construction in the Chemical Industry.** M. G. Fontana. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 359.—The

use of synthetic rubber and plastics as materials of construction in the chemical industry is discussed. The five basic commercial synthetic rubbers—namely, GR-S type, neoprene, nitrile, butyl and Thiokol and the phenolic, vinyl, silicone, nylon, styrene, polythene and acrylic plastics—are included. Actual uses in the chemical plant are described. Numerous types of chemical equipment are involved. Information on the physical and chemical properties of these materials is presented.

Reference is made to the use of these materials in petroleum plant, including nitrile rubber for lining steel tanks holding hydrocarbons containing hydrochloric acid; a modification, Hycar, when resistance to both mineral acids and aromatics is required; Thiokol for lining concrete and steel tanks storing aviation gasoline. Reference is also made to the use of a silicone lubricant for plug cocks handling 50% caustic and 93% sulphuric acid, moulded nylon plant components resistant to oil, grease, aromatic gasoline, heat, alkalis, etc. A. R. J.

**917. Present-Day Hydrogen Manufacturing Processes.** R. M. Reed. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 379.—This paper describes the hydrogen manufacturing processes that are in use on a commercial scale at the present time in the U.S.A. These processes include the following: 1. The electrolysis of water; 2. The steam-iron process; 3. The steam-water gas process; 4. The steam-hydrocarbon process; 5. The steam-methanol process; 6. The thermal decomposition of hydrocarbons.

The present production of hydrogen in the U.S. amounts to about six billion cu. ft per month, of which about three billion cu. ft per month are produced and utilized in the manufacture of synthetic ammonia. A. R. J.

**918. Surface Required for Exchangers.** W. L. Nelson. *Oil Gas J.*, 27.4.46, **44** (51), 145.—Issue No. 90 in the *Refiner's Notebook* series concerns the calculation of the amount of surface required for an exchanger system. A formula is developed, depending on average temperature difference, fouling factors, and film-transfer rates; the latter two factors will be presented in future issues (91, 92, 94, and 95). G. A. C.

**919. Over-all Transfer Ratio (Refiner's Notebook No. 96).** W. L. Nelson. *Oil Gas J.*, 8.6.46, **45** (5), 105.—Methods of computing heat transfer rates between two liquids are given.

Each of the two fluids and degree of fouling of the two surfaces must be considered, and only when direct experimental results are available on the equipments concerned can these variables be ignored.

Rates are calculated for a gasoline exchanger and condenser, with reference to data given in previous Refiner's Notebooks (91 to 94). G. A. C.

**920. Italian Refinery Capacity Down to Only 40 Per Cent of Pre-War.** A. Giordano. *Oil Gas J.*, 1.6.46, **45** (4), 46.—A review is made of the refining capacity of the Italian oil industry. All the refineries, with the exception of that at Bari, have been almost completely destroyed by air raids, capacity having been reduced to 40% of the pre-war of nearly three million tons. For example, the Fornovo refinery was completely destroyed except for boiler plant. All the latest type plant, including thermal cracking, Houdry catalytic cracking, and hydrogenation units, were located at Fiume and Leghorn, and were destroyed. The Azienda Nationale Idrogen-cazione Combustibili is considering exploiting the Bari plant, using salvaged equipment from the Leghorn units. Hydrogenation output is important, and in the Piacenza district wells have been drilled with a daily output of 3000 brl. Methane gas output in Northern Italy is about 8,830,000 cu. ft yearly, and a project has been worked out to pipe gas to the ports on the Po River and the Adriatic for fuelling gas-driven water transport. G. A. C.

**921. Texas Company will Build Major East Coast Refinery.** Anon. *Oil Gas J.*, 18.5.46, **45** (2), 90.—The Texas Co. are to build a refinery on the Delaware River, strategically located to receive foreign and domestic crudes. It will process motor gasoline, diesel, furnace and industrial fuel oils, using latest type refining processes. The plant will commence operation in 1948. The company's 20 other refineries in the States, and capacities are listed, together with interests in South America and the Middle East. G. A. C.

## Distillation.

**922. Newly Developed Process Secures Pure Hydrocarbons from Petroleum.** Anon. *Nat. Petrol. News*, 3.4.46, **38** (14), R-283.—A procedure for separating paraffinic, naphthenic, or cyclic hydrocarbons is described.

The method known as the "Distex" process employs both solvent refining and conventional distillation. A narrow boiling stock containing both the paraffin and cyclic fractions is separated into two types by the Distex operation, final processing consisting of individual fractionations of the two single-type fractions into their respective components. The separation is nearly independent of the molecular weight or boiling point of the compound.

The boiling point of the solvent in the Distex process is not important so long as it is above that of the hydrocarbon.

Laboratory pilot-plant operation was carried out using aniline as the solvent for safety reasons. A flow diagram is given for a *n*-heptane-methyl*cyclo*hexane-aniline mixture. The tower was also tested with a hexane fraction from "Skellysolve B" with a boiling range of 148° to 165° F, overhead products amounting to 60% charge and almost entirely paraffinic being obtained.

A schematic flow-sheet for a commercial-sized plant using "Skellysolve B" as an example, is also given. G. A. C.

**923. Precise Fractionation of Light Hydrocarbons.** F. H. Stone. *Refiner*, 1946, **25** (4), 124–128.—A modified McCabe–Thiele method is applied to calculate the number of bubble trays and reflux ratio required for the fractionation of iso- and normal butane and iso- and normal pentane. The actual number of plates depends on plate efficiency and this depends partly on plate design. Minimum reflux ratio data indicates that operating pressure has much less bearing on reflux requirements than does the composition of the fractionator feed. The diameter of a fractionator may be calculated by means of an entrainment formula which will indicate the vapour velocity at which liquid will carry from plate to plate up the fractionator. Since the volume of reflux required for the fractionation of the butanes so far exceeds the volume of fractionator feed or products, this reflux volume is the determining factor in arriving at fractionator diameter. It is also the largest single factor in determining the size of overhead condensers, cooling tower, and cooling water requirements, the reboiler size, quantity of heating steam required, and the size of reflux and circulating water-pumps. G. R. N.

**924. Calculation of Minimum Reflux Ratio for Multicomponent Distillation.** F. D. Mayfield and J. A. May. *Refiner*, 1946, **25** (4), 101–108.—A method is presented for calculation of minimum reflux ratio which is quite rapid, but is limited at the present development to complete reparations of mixtures which involve only one component in the distillate or only one component in the bottom product. Excellent agreement was obtained with Colburn's method and the plate by plate method. G. R. N.

**925. A Simplified Method for Solving Multicomponent Distillation Problems.** R. J. Hengstebeck. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 309.—A graphical method similar to the McCabe–Thiele method for binary separations has been devised for quickly and accurately solving multi-component distillation problems in systems for which the usual assumptions of constant molal overflows in the rectifying and stripping sections are valid, and in which there are no intermediate components between the key components. The method is applicable both to sharp and sloppy separations.

A modification is presented for the calculation of separations of groups of components (as in depropanization, debutanization, etc.).

In addition to being quick and accurate, the method has the further advantage of locating the feed-tray directly.

In the simplified method the multi-component system is reduced to an "effective" binary system by the use of certain approximations, and the number of plates required for the desired separation is determined graphically for an arbitrarily assumed reflux ratio.

Nine separations have been calculated by the simplified method and checked by

rigorous calculations. For these separations the average deviation of the number of trays calculated by the simplified method from the number calculated rigorously was 0·5 theoretical plate. The maximum deviation was 0·8 theoretical plate.
A. R. J.

**926. Extractive Distillation—Separation of $C_4$ Hydrocarbons Using Furfural.** J. Happel, P. W. Cornell, DuB. Eastman, M. J. Fowle, C. A. Porter, and A. H. Schutte. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 189.—The butadiene plant of the Nèches Butane Products Co. employs furfural as an extractive distillation medium for three separations: *iso*butane from butene-1, *n*-butane from butene-2's, and butene-1 from butadiene. Extractive distillation is necessary for the separation of the $C_4$ hydrocarbons because of their close boiling points.

This paper presents techniques developed for the operation of such equipment and test data showing typical performance. It has been found that for a given solvent circulation, the best separation will be obtained with the highest proportion of hydrocarbon that can be dissolved in the solvent without causing the separation of a hydrocarbon rich phase in the tower. Means for obtaining this optimum condition are discussed. Average plant data taken over a five-month period show that excellent performance is possible with this type of equipment. Plant tests indicate that the average tray efficiency is close to 25%.

In the course of this work some new methods were developed for calculating tray efficiencies from test data and for the estimation of activity coefficients in multi-component mixtures from binary data. It is believed that these methods are of more general applicability.
A. R. J.

**927. Thermodynamic Evaluation of Binary and Ternary Liquid Systems.** K. Wohl. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 215.—The art of distillation of liquid mixtures is based on the knowledge of vapour–liquid equilibria. In order to obtain this knowledge with a minimum of experimental data, equations for the activity coefficients in the liquid mixture are required. A special need for such equations exists in the case of non-ideal multi-component systems as are encountered in azeotropic and extractive distillation. Several equations have been proposed in the literature, but the form in which they are given often does not make their application simple, and the diversity of their forms adds to the difficulty of choice between them.

In this paper equations for the activity coefficients in binary and ternary liquid mixtures of the types of the van Laar, the Margules, the Scatchard–Hamer equation and those of a more general type have been presented. They are given first in their simplest form, in which only the second power of the mole fractions is used and, further, in forms in which the third and fourth powers are applied. All of them have been written in such a way that they appear as variations of one mathematical scheme, so that a transition from one type to the other is obvious. All contain as principal constants the end values of the activity coefficients in the binary systems, which should simplify their practical application. The systematical investigations of the various types of equations resulted also in a few equations which have not been considered so far, but which may prove useful. A survey is given of the presumable range of valididy of the equations presented.
A. R. J.

**928. Gas–liquid Equilibria in the Petroleum Industry.** W. R. van Wijk. *Ingenieur*, 1946, **58**, M. 41–45.—A general discussion of gas–liquid equilibria in distillation and condensate recovery.
M. B.

**929. New Cycling Plant Consumes Gas; Produces 300,000 Gallons products Daily.** A. L. Foster. *Oil Gas J.*, 1.6.46, **45** (4), 60.—The new Shell plant at Sheridan, Texas, is described. This plant commenced operating in 1945, processing gas from 15 wells. Gas is drawn from two horizons, one at 9,300 ft and the other at 10,300 ft at approximately the same rate. A throughput of 95 million feet daily has been reached. The gas passes into two parallel scrubbers, thence to two high-pressure absorbers, the two streams being combined before entering flash-tanks where distillate and fat oil are separated. Flashing or venting takes place in three successive stages, the raw distillate being led to a stripper, and the flashed fat oil is brought into heat exchangers and flashed at 120 p.s.i.g. The main oil stream is processed in

a still equipped with a special section and draw-off near the top. A rectifier, depropanizer, debutanizer, butane, and pentane fractionator units form part of the equipment; propane, iso- and normal butane, iso-pentane, gasoline, and distillate are the products. The stripped gas is returned to five input wells, all return gas being metered into the well. G. A. C.

## Absorption and Adsorption.

**930. High Pressure Absorption Plant.** C. C. Pryor. *Refiner*, 1946, **25** (4), 117–123.—A description of the cycling plant at the Sheridan field, Texas. With a wet gas capacity of 100,000,000 cu. ft/day the two absorbers are operated at 1800 lb/sq. in gauge and 100° F using lean oil sp. gr. 0·825/0·850, mol. wt. 200/225, and I.B.P./F.B.P. 250°/340° C. The distillate stripper and the fat oil still are controlled at 125 lb and 425° F and 65 lb and 470° F, respectively. The raw gasoline is rectified at 450 lb and 275° F, then fractionated to give propane, *iso*- and normal butanes, *iso*-pentane, and natural gasoline. Material balance, tower-pump schedule, and tower schedule are tabulated. Precision fractionation of the light ends gives a recovery efficiency of 85% minimum total butanes and 99% minimum total *iso*-pentane and heavier propane, *iso*- and *n*-butanes, and *iso*-pentane are produced with a purity of 95%. G. R. N.

**931. Practical Refrigeration for Natural Gasoline Plants.** R. W. Heath, J. B. Taylor, Jr., and P. W. Hill. *Refiner*, 1946, **25** (3), 93–100.—Propane refrigeration can be justified in new low-pressure (below 100 lb) absorption plants where the future maximum volumes of wet gas are known. Refrigeration is also felt to be simplest, cheapest, and most economical means of securing additional plant capacity in existing units. The advantages of refrigeration are due not only to the reduction in vapour pressures, but also to the greater spread of vapour pressures between the hydrocarbon components at the lower temperatures, which in turn results in better separation of the fixed gases. Refrigeration lowers the temperature of the fat oil entering the exchangers, increasing the mean temperature difference within the oil, and lowers the lean oil temperatures to the coil. Thus the coils are required to extract less heat and the residual dry gas content of the lean oil is reduced. There is a smaller loss of gasoline in the dry gas, which allows the use of absorption oil of lower mol. wt. and increased absorption efficiency. The costs of installing a refrigeration unit capable of sub-cooling the lean oil by 25° F are small in terms of equivalent oil rate. Details of two plants operating on propane refrigeration are given. G. R. N.

## Solvent Refining and Dewaxing.

**932. Liquid–Liquid Extraction in Spray Towers.** H. F. Johnson, Jr., and H. Bliss. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 331.—Experimental work on liquid–liquid extraction is presented, which work includes 109 extraction runs with four systems in a 1·824 inch I.D. tower. Major emphasis is placed on the extraction coefficient, Ka, and distribution, but some attention is given to the flooding phenomenon. Ka increases with both dispersed and continuous phase-flow rates, increases slightly with increases in entering solute concentration, and tends to decrease somewhat with increase in tower length. When extraction is from continuous to dispersed phase, Ka is greater and drop coalescence is less than when extraction is in the other direction. Optimum distributor design is discussed. Correlation methods for roughly predicting overall coefficients for one system in a specific spray tower from data taken with another system in the same apparatus are suggested. Comparisons are made among spray, packed, and perforated plate towers, and conditions in which the spray tower may well be advantageous are deduced from these results. A. R. J.

**933. Improved Technology = Better Lube Oils.** G. Armistead. *Oil Gas J.*, 27.4.46, **44** (51), 124.—Solvent extraction, deasphalting, and dewaxing processes are reviewed.

Solvent extraction is employed to remove or reduce non-paraffinic components, the six processes in use have a capacity of 90,000 brl/day.

Deasphalting with liquid propane is used to remove asphaltic materials insoluble

in petroleum naphtha, thus improving carbon deposition, oxidation resistance and viscosity index. Solvent dewaxing, capacity 64,000 brl/day, removes waxes and improves pour point. G. A. C.

**934. Some Solvent Extraction Developments in Germany.** J. P. Jones. *Nat. Petrol. News*, 6.3.46, **38** (10), R-181.—In this second instalment the separation of low-temperature carbonization tar distillate into raffinate and extract is discussed.

The use of the triangular co-ordinate graph technique to supply data on the relationship between solvent, raffinate, and extract phases necessary for commercial operations is illustrated. For example, from the graph it appears that by an isothermal extraction of low-temperature carbonization tar distillate at 40° C it is possible to separate it in two stages into the best possible raffinate and extract.

In practice the final product obtained at 40° C can be further separated by cooling to minus 10° C.

The method is also applied to the use of naphtha to separate an $SO_2$-extract from a tar from low-temperature carbonization of brown coal. G. A. C.

## Cracking.

**935. Small Fluid Cat Cracker Designed to Compete with Units of Larger Capacity.** Anon. *Oil Gas J.*, 8.6.46, **45** (5), 97.—A development in the design of catalytic cracking operations for use in refineries of small capacity is described.

Economic considerations make it imperative that catalytic cracking is employed for the production of high-quality gasolines. A flow chart of such a unit is given, and the economics of 4500 brl and 9500 brl/day plants is tabulated. The conventional processing sequence including topping, conditioning reduced crude, fluid catalytic cracking, catalytic polymerisation, thermal cracking of cycle stock, and thermal reforming of heavy naphtha is assumed.

5·3% gasoline is obtainable from a 4500 brl/day refinery with 1700 brl/day catalytic cracking capacity, showing an operating credit of $700,000 per year before depreciation and taxes; and one of 9500 brl/day can show a similar credit of $1,200,000. Thus initial cost of installation still allows a worth-while profit even after depreciation and amortization charges. Over-design features of the older larger plants have been eliminated in the small units, less piping and framework are required, and elevators dispensed with. For a 4000 brl/day unit the main structure occupies only 1650 sq. ft area; elevation of support of reactor, regenerator and precipitator being only 69 ft above ground level.

Units have to be designed to employ the fluid principle of powdered catalyst circulation and use all tested catalysts, be capable of handling heavier or any kind of charge stocks, and be flexible to meet varying market demands. Low-pressure operation is essential for economical operating costs, a spent catalyst stripping system is necessary, and a single-stage cyclone is placed in the reactor and regenerator to avoid loss of catalyst. Catalyst is recovered from product streams by a scrubbing system.

Control by automatic instruments and long continuous runs are important factors in obtaining maximum power. G. A. C.

**936. Developments in Fluid Catalytic Cracking.** J. F. Walter. *J. Inst. Petrol.*, June 1946, **32** (279), 295–312.—After a survey of the development of fluid catalytic cracking it is concluded that the experience built up during the war, the laboratory and pilot-plant developments of the past several years, have led to a considerably simplified design, with an attendant marked reduction in cost, improvement in gasoline yield, and reduced operating costs. Methods have been developed for forming synthetic catalysts into very small spheres, and catalyst in this form shows, when compared to ground catalyst, a considerably reduced rate of attrition to unrecoverable fines and an increased ease of recovery from gases or vapours. Three compositions of catalyst are available for fluid cracking—namely, silica-alumina, natural, and silica-magnesia—the best catalyst for a given application being determined by the octane number of the gasoline which must be produced and by the requirements for raw materials for chemicals. Since fluid catalytic cracking units are capable of cracking oil at high temperatures, and for this reason permit maximum

production of light mono-olefines by the catalytic cracking route, its application to the production of light olefines for chemical manufacture should be investigated by those interested in this activity. The discussion is reported. A. H. N.

**937. Cracking of Heavy Petroleum Stocks Over Heated Surfaces.** A. Ya. Larin. *Nat. Petrol. News*, 3.4.46, **38** (14), R-286.—Laboratory experiments on the cracking of oil distillates over electrically heated metallic spirals are described.

The experiments were carried out using a pyrex flask fitted with 4 or 5 electrodes and fitted with spirals heated by 120-volt A.C. One spiral at a time was used until the entire charge was cracked or all spirals became covered with cabon. The consumption of electrical current was noted, and different metals such as tunsgten, molybdenum, platinum, iron, nickel, etc., were used in a series of experiments. Materials cracked were paraffin wax, mazuts from a commercial unit processing Grozny wax-bearing oil, from Zykh and from Kara-Chukhur oils, and oil distillate from Grozny wax-bearing oil. A gas is produced under the conditions of the experiment having a composition approximately similar to that obtained from paraffin wax. The yields of gas per unit energy consumed are the lower, the richer is the charge in compounds with a low hydrogen content.

An oil distillate consisting essentially of naphthenes gives a yield of gas per k. wt-hour which is half that obtainable from paraffin wax. An oil distillate containing up to 21% aromatics gives about one fourth of the amount of gas obtainable from paraffin wax.

From fuel oils the yields of gas are still lower, and show fluctuations depending on the contents of resins and carboids in the charge. Tables show the comparison of yields from paraffin wax, kogasin and mazuts. G. A. C.

**938. Principles of Reactor Design.** C. O. Reiser and K. M. Watson. *Nat. Petrol. News*, 3.4.46, **38** (14), R-260.—This article deals with the pyrolytic dealkylation and concentration of aromatics.

The laboratory equipment used was designed for pyrolysis at atmospheric pressures in the presence of steam or other diluents at temperatures up to 1600° F. Compressed air was used to force liquid to the reactor. The reactor consisted of a 1-inch standard pipe of 18% Cr, 8% Ni steel mounted vertically in an electric furnace.

Ultra-violet spectrophotometric methods of analyses were used to determine the aromatic contents of the treated factors.

Xylene, toluene and a heavy hydroformed naphtha containing 23% xylenes and 9% toluene were cracked at about 1450° F. Approximately 40% of the xylenes were destroyed in raising the concentration of the xylene fraction of the naphtha from 49% to 90%, but benzene and toluene were formed and the loss in total $C_8$, $C_7$, and $C_8$ aromatics was only 14%.

A method of kinetic analysis is mathematically developed for such data in flow streams whereby the individual velocity constants and product distributions of the various reactions are evaluated; integration of the equations gives good agreement with experimentally observed results.

The integration is demonstrated and may be used for predicting the results of any reactor operating under conditions to which the basic data is applicable. For example, if the reaction is conducted in an adiabatic chamber the temperature change in each small section can be calculated from the conversion and the thermochemistry of the reactions. Thus the optimum design for a reactor required for a specific duty can be systematically obtained. G. A. C.

## Hydrogenation.

**939. New Plant will Provide Pattern for Synthetic-Liquid Fuels Industry.** F. R. Staley. *Oil Gas J.*, 27.4.46, **44** (51), 118.—A plant to produce 110,000 cu. ft of hydrogen and 120,000 cu. ft of synthesis gas daily for investigation of the hydrogenation and gas synthesis processes is to be erected at Bruceton, Pa.

Desulphurized natural gas is heated with steam to 1,500° F over a catalyst to form carbon monoxide and carbon dioxide. Nickel compounds on a refactory support reduced in hydrogen or in the reaction mixture, give long life as catalysts, with rapid reaction rate and minimum of undesirable side reactions. The gaseous mixture is

cooled to 700° F by addition of steam, with which it reacts in a converter to produce carbon dioxide and hydrogen, 90–95% of the monoxide being converted to the dioxide.

Carbon dioxide is removed from the cooled gases by scrubbing with an aqueous solution of mono-ethanolamine. Again mixed with steam at 700° F, the purified gas is passed to a second monoxide converter, cooled and purified by absorption in the amine.

Seventeen plants with a total capacity of 4 billion cu. ft per month use the process.

G. A. C.

## Polymerization.

**940. Poly Plant Converts to Peace.** H. E. Chambers and W. L. Pursell. *Oil Gas J.*, 18.5.46, **45** (2), 118.—The peace time operations of the polymerization unit of Skelly Oil Co., El Dorado, Kansas, is described. This is a Kellog chamber-type plant using copper pyrophosphate catalyst with four reactors, for manufacture of aviation gasoline components during the war. It has now been converted to the production of polymer blending stocks for motor gasolines. A feature lies in bringing a freshly charged reactor on stream, a butanes and lighter stream being pumped through the heater and to the top of the fresh reactor; the stream being pumped away from the bottom whilst the reactor has been brought to temperature and is switched on stream in series with other reactors. Feed velocity is 2625 lb/sq. ft of reactor cross section, giving a pressure drop of 50 lb through the four reactors. Propylene and butylene are 2·5% of the total crude run, and 86% of these are charged to the polymerization unit. 140 gal of product per pound of catalyst is obtained. G. A. C.

## Alkylation.

**941. Corrosion in Hydrofluoric Acid Alkylation.** F. A. Prange and R. A. Findlay. *Refiner*, 1946, **25** (3), 85–88.—It is concluded that thorough metallurgical investigation and the use of a "corrosion pilot plant" did much to facilitate the rapid development of the H.F. alkylation process from a lab. to plant scale. Ample large-scale experience combined with these investigations has demonstrated that carbon steel suffers very little corrosion in equipment in this process up to temperatures of about 150° F. Monel is satisfactory for considerably higher temperatures and is adequate for the severe conditions of aqueous acid plus oils drawn from the bottom of the acid screen unit at 275–300° F. Copper alloys, with the exception of cupro-nickels, have been found unsatisfactory for concentrated acid service where liquid velocities are high. Chrome stainless steels are also sensitive to velocity.

G. R. N.

## Chemical and Physical Refining.

**942. Patent Trends in Petroleum Refining.** P. J. Gaylor. *Nat. Petrol. News*, 3.4.46, **38** (14), R-251.—New patents disclosing a synthetic lubricant, extreme-pressure lubricants, a viscosity index improver, and soluble oils are discussed.

A Sinclair patent, U.S. 2,395,380, describes an ester-ether mixture of tri-*o*-butyl and tri-*o*-cresyl phosphates and ethylene glycol monobenzyl ether which is claimed to have excellent load-carrying properties, is non-corrosive to metals, and is non-toxic.

U.S.P. 2,395,379 discloses the use of benzaldehyde as a low-temperature lubricant; other patents disclose potent extreme pressure lubricants (U.S.2,394,734), and another claims the use of a polyester by reacting equimolecular proportions of tri*iso*butylene, succinic acid, and decamethylene glycol as a viscosity index improver.

A Cities Service patent (U.S. 2,394,965) discloses a process for manufacturing lubricating oils resistant to oxidation and sludge formation. A Sun Oil Company patent (U.S. 2,395,627) describes a method for producing a material consisting of lubricating oil containing alkali metal soaps of weak synthetic acids, which forms stable water-in-oil emulsion. A flow-sheet of the method is given. G. A. C.

## Special Processes.

**943. The Dow Process for Styrene Production.** J. E. Mitchell, Jr. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 293.—Because of the large part played by styrene in

the synthetic rubber programme, and because of its growing importance in plastic materials, a description of the Dow styrene process seems desirable. This process, used in whole or in part by six of the seven styrene plants in the U.S. and Canada, is producing about 90% of the total styrene made in the U.S.A.

The basic chemistry consists of: (1) Alkylation of benzene with ethylene in the presence of aluminium chloride to form ethylbenzene; (2) Catalytic dehydrogenation of purified ethylbenzene in the presence of steam to give styrene.

Flowsheets are presented for the three essential steps; ethylbenzene production, ethylbenzene dehydrogenation, and styrene finishing. The correlation of operating results with theoretical considerations is brought out. An analysis is made of the most important problems which had to be solved in developing the process to its present status.

The plant layout at Velasco, Texas, as well as specific items of equipment are illustrated and described. Average yields throughout the process are presented.

A general comparison is made between the Dow styrene process and the one used by I.G. Farbenind. in Germany. A. R. J.

**944. Process Design of Catalytic Reactors—Dehydrogenation of Butane.** R. H. Dodd and K. M. Watson. *Trans. Amer. Inst. chem. Engrs*, 1946, **42** (2), 263.—A small pilot plant was designed and built for the engineering analysis of catalytic processes. The design permits operation over wide ranges of conditions on a variety of systems employing solid catalysts. Operation can be either as an "Integral reactor," to simulate the results of a commercial reactor, or as a "differential reactor" for the direct determination of absolute reaction rates. Such equipment, coupled with sound thermodynamic and kinetic principles, permits the establishment of optimum process conditions from a relatively few small-scale experiments. It is believed that in many cases the usual period of pilot-plant and semi-commercial experimentation may be omitted and optimum large-scale equipment designed directly from fundamental kinetic measurements.

Operability of the equipment was demonstrated by a short study of the dehydrogenation of butane over a chromia-alumina catalyst. It is indicated that the rate of dehydrogenation is controlled by a surface reaction involving dual active centres. The overall selectivity of the reaction is reduced by the cracking of both butane and butenes.

On the basis of these results and data from the literature, simplified equations are developed which permit partial prediction of the results of commercial reactors over wide ranges of conditions. These equations are integrated for isobaric, isothermal reactors to show the variation of conversion and selectivity with temperature, pressure and space velocity. More data are needed for a complete and rigorous analysis. A. R. J.

**945. Patent Trends in Petroleum Refining.** P. J. Gaylor. *Nat. Petrol. News*, 6.3.46, **38** (10), R-190.—Some new U.S. patents in connection with asphalts, waxes, lubricants, fire extinguishing, chemicals, and diesel fuels are reviewed.

U.S.P. 2,389,680 discloses the use of amino alkylamides of carboxylic acids as binding agents to improve the adhesivity of asphalts, and a table gives the stripping resistance test results. U.S.P. 2,383,521 specifies the use of tetramyl silicone in dewaxing to obtain an oil-free wax of better colour, greater hardness, and higher purity. U.S.P. 2,377,654 describes a foaming resistant gear lubricant prepared by the addition of 0·2–1% of potassium oleate to a 5–10% sulphurized sperm-oil blend; test results are given in a table. Greases containing picoline and silver-stearite are disclosed. The dilution of ethyl bromide by methyl bromide and ethylene chlorobromide to reduce its cost as a fire extinguisher is described in patent 2,389,652; and the production of dialkyl phthalates and chloroprene is described in patents 2,391,849 and 2,391,827.

A Socony-Vacuum patent 2,392,570 covers the removal of aromatics from diesel fuels. G. A. C.

## Metering and Control.

**946. Fractionation Columns.** D. M. Boyd, Jr. *Refiner*, 1946, **25** (4), 147–151.—A straightforward analysis of the problems of control of fractionators subdivided into:

(1) Stripping section temperature control; (2) Rectification section temperature control; and (3) Material balance control. Control of a batch column is also discussed. G. R. N.

**947. Orifice Meter in Natural Gasoline Measurement.** R. W. Weeks. *Refiner*, 1946, **25** (4), 135–139.—After several years' experience of meter problems in the processing of natural gasoline and light hydrocarbons the author has developed tabulations of meter factors for this application and presents the generally accepted basic data in a usable and accurate form. The tables, charts and calculations given apply to properly constructed meter runs and where the line static pressure is approx. one and one half greater than the vapour pressure of the flowing liquid. G. R. N.

**948. The Effect of Measurement Dead Time in Process Control.** D. P. Eckman. *Refiner*, 1946, **25** (3), 117–120.—A series of automatic control tests are reported, which demonstrate the importance of instantaneous controller mechanism response in self-balancing potentiometer controllers. The tests were made with both two-position and proportional-reset control. Other tests dealing with the importance of measurement dead zone of the controller are excluded, noting the relation between dead zone of measurement and dead time of controller response. G. R. N.

## Safety Precautions.

**949. Programme of Safety Inspection.** G. Armistead, Jr. *Oil Gas J.*, 20.4.46, **44** (50), 150.—A general discussion is presented on the object and scope of the periodic inspection of refinery equipment. Reference is made to the already standardized inspection processes and to the necessity for checking and developing these methods to meet the advent of newer types of plant and materials introduced during the war years. Emphasis is laid on the proper organization of the refinery inspection department and the need for its personnel to fully appreciate their responsibility in maintaining safety of equipment. I. W. E.

**950. Check Your Tube-Still Refractory Lining Maintainance Programme.** H. O. Johanson. *Oil Gas J.*, 1.6.46, **45** (4), 69.—Methods and materials for repair and maintenance of tube-still refractory lining are outlined.

Door openings, such as access, explosion, and peepholes, tube hangers, and corners, are the major source of maintenance in suspended walls. Door trouble can be reduced by filling with insulating fire-brick, leaving a small opening as a peephole. Intermediate tube hangers should be correctly designed with a rib to protect the opening and retain the expansion joint material.

Expansion joints should be inspected and repacked. The steel forming the header-box compartment should be insulated, and thus refractory arch trouble at the end roof supports eliminated. Correctly designed offset joints at corners where side walls lap the front, rear, or bridge walls will eliminate trouble, and such joints should be repacked when necessary. Suitable material for packing is a mixture of 50% broken block or plastic insulation with 50% fine clay.

Refractory lined walls should be frequently inspected for leakage, or for failure due to melting, softening, fluxing, spalling, and expansion. Due to its low temperature, melting and softening are not troublesome in a tube-still, fluxing can be avoided by choice of suitable refractories, spalling and expansion problems can be avoided by correct design. G. A. C.

**951. Gamma Ray Inspection Method Used to Determine Loss in Wall Thickness of Equipment Serving Gas-Distillate-Wells.** E. H. Short. *Oil Gas J.*, 29.6.46, **45** (8), 119.—The use of the Penetron equipment as a means of measuring wall thicknesses of metal equipment of gas-distillate-wells is described and the results obtained with the instrument at 16 selected points in a lateral loop are recorded, in comparison with micrometer measurements taken after torch cutting the loop at 7 of the points, show a high degree of accuracy. The Penetron instrument was developed by the Texaco Development Corpn and is sold by Engineering Laboratories Inc., Tulsa. The instrument, its method of functioning and operation are described. Briefly it makes use of the gamma radiations from 1 mg. radium situated in the head of the

instrument, the head also contains a detection that receives the pulsations returned ("back-scattered") by the metal, and forms the means by which the intensity of the returned radiations are measured. The intensity of the radiations increases as a function of the wall thickness. A more detailed account of the Penetron equipment, method of working and operation, is given in the paper described in abstract No. 1143 (1945). W. H. C.

**952. Treatment of Hot Resin Burns.** W. B. Warden and W. J. Sigmund. *Refiner*, 1946, **25** (3), 89–92.—The discussion of burns resulting from accidental contact with hot asphalt-like materials is presented primarily from the first-aid view-point, although one important feature of the subsequent treatment is suggested for the consideration of the medical profession. The methods proposed involve two radical departures from ordinary procedures. The first-aid steps include: (1) cool rapidly with water, (2) treat for shock, (3) call a doctor, (4) apply a burn ointment or medicated jelly over the resin and surrounding areas and bandage loosely and (5) do not remove the resin. In addition to the actual burn treatment, some definite recommendations are made regarding the handling of hot resinous or thermoplastic-type materials both in plant and laboratory. More effective co-operation between chemists and doctors is stressed. G. R. N.

## PRODUCTS.

### Chemistry and Physics.

**953. The Purification and Physical Constants of Aromatic Hydrocarbons.** L. C. Gibbons, J. F. Thompson, T. W. Reynolds, J. I. Wright, J. H. Chanan, J. M. Lamberti, H. F. Hipsher, and J. V. Karabinos. *J. Amer. Chem. Soc.*, 1946, **68**, 1130–1131.—A note giving the freezing point, boiling point, density and refractive index ($n_D^{20}$) of benzene, toluene, ethylbenzene, *n*-propylbenzene, *iso*-propylbenzene, *o*-xylene, *p*-xylene, *m*-diethylbenzene, *p*-cymene, 1 : 3 : 5-triethylbenzene, and 3 : 5-diethyltoluene prepared in bulk for aeronautical research. G. R. N.

**954. Isomerization Equilibria among the *n*-Butenes.** H. H. Voge and N. C. May. *J. Amer. chem. Soc.*, 1946, **68**, 550–553.—Isomerization of the *n*-butenes was effected by passage over granular catalysts such as silica-alumina-magnesia and Porocel bauxite at temperatures in the range 200° to 630° C. *trans*-2-Butene is the most stable isomer at the lower temperature, but 1-butene and *cis*-2-butene are nearly as stable at the higher temperature. Equilibrium consts. and free energy changes for the isomerization reactions are given, and the results are compared with thermochemical measurements and with other data. G. R. N.

**955. Isomerization of Alkanes. I. Effect of Olefins upon the Isomerization of *n*-Butane.** H. Pines and R. C. Wackher. *J. Amer. chem. Soc.*, 1946, **68**, 595–599.—Isomerization of *n*-butane in the presence of $AlCl_3$–HeI and $AlBr_3$–HBr catalyst has been studied using high vacuum technique. Under certain conditions paraffin hydrocarbons do not undergo isomerization by means of aluminium halide–hydrogen halide catalyst unless olefins are present or probably formed *in situ*. It was assumed that the olefins function as a source of carbonium ion. The addition of one part olefin per 10,000 parts of *n*-butane is sufficient to promote isomerization. The effect of olefins, temperature and concentration of HCl upon the degree of isomerization is given. G. R. N.

**956. Isomerization of Alkanes. II. Effect of Oxygen on the Isomerization of *n*-Butane and *n*-Pentane.** H. Pines and R. C. Wackher. *J. Amer. chem. Soc.*, 1946, **68**, 599–605.—It was found that the addition of 0·007 mole per cent oxygen in the form of air to *n*-pentane is sufficient to convert 40% of the *n*-pentane to butanes and *iso*-pentane using $AlCl_3$ catalyst; in the absence of oxygen there is no reaction. Studies were made of (*a*) the $AlBr_3$–oxygen–hydrocarbon complex formed by the action of air on a *n*-butane solution of $AlBr_3$, (*b*) the action of oxygen on $AlBr_3$, and (*c*) the effect of ethyl aluminium dibromide and of diethylaluminuim bromide on *n*-butane isomerization in the presence and in the absence of air. G. R. N.

**957. Thermodynamics of 2 : 2-Dimethylbutane.** J. E. Kilpatrick and K. S. Pitzer. *J. Amer. chem. Soc.*, 1946, **68**, 1066–1072.—The heat capacity of 2 : 2-dimethylbutane has been measured from 15° to 280° K and the vapour pressure from 211° to 290° K. The following values were obtained: heats of transition 1289·2 ± 3 cal./mole at 126·81° K; 67·7 ± 1 cal/mole at 140·88° K; heat of fusion 138·5 ± 0·5 cal/mole at 174·16° K; entropy at 298·16° K, 65·13 ± 0·15 for the liquid and 85·72 ± 0·2 cal/degree mole for the ideal gas. A vibrational assignment is made and the average potential barrier to internal rotation calculated to be 4375 cal/mole. G. R. N.

**958. Thermodynamics of *cyclo*Propane.** R. A. Ruehrwein and T. M. Powell. *J. Amer. chem. Soc.*, 1946, **68**, 1063–1066.—The heat capacity of solid and liquid *cyclo*propane has been measured from 15° K to the boiling point. The m.p. and b.p. were 145·54° and 240·30° K respectively. The heats of fusion and vaporization were determined colorimetrically and were 1301 and 4793 cal/mole$^{-1}$ respectively. The density of *cyclo*propane gas at 298·1° K and one atmosphere was 1·7463 gms/litre. The vapour pressure of liquid *cyclo*propane is given by an equation derived from the data obtained. The most reliable value of the entropy of the gas is given as 56·84 cal/degree per mole at 298·1° K and one atmosphere. G. R. N.

**959. Thermodynamic Properties of Gaseous 1 : 3-Butadiene and the Normal Butenes above 25° C. Equilibria in the System—1 : 3-Butadiene, *n*-Butenes, and *n*-Butane.** J. G. Aston, G. Szasz, H. W. Woolley, and F. G. Brickwedde. *J. Chem. Phys.*, 1946, **14**, 67.—Tables of thermodynamic properties of 1 : 3-butadiene and the three normal butenes in the ideal gas state for temperatures from 298·16° K to 1500° K at one atmosphere pressure are given. These have been prepared using spectroscopic and molecular data, together with calorimetric entropies, gaseous specific heats and heats of formation. Equilibrium constants are given for reactions in the system 1 : 3-butadiene, *n*-butenes, and *n*-butane. Available experimental data are compared with the calculations. The calorimetric data for 1 : 3-butadiene furnish strong evidence for the existence of *cis-trans* isomeric forms of 1 : 3-butadiene in appreciable concentrations at room temperatures. The two forms differ in energy by 2·3° K cal.mole$^{-1}$ and are separated by a C–C rotational barrier 2·6° K cal.mole$^{-1}$ above the lowest energy level of the *cis*, or higher, energy form. J. T.

**960. The Mercury Photosensitised Reactions of Propylene and Isoprene.** H. E. Gunning and E. W. R. Steacie. *J. Chem. Phys.*, 1946, **14**, 47.—An investigation has been made of the reactions of propylene and isoprene with mercury ($^3P_1$) atoms at 30° C in a static system. The reactions are similar in that the rates of consumption of both propylene and isoprene decrease with increasing pressure in the range of complete quenching. In addition, the quantum yields of both reactions are low. The products of the propylene reaction are liquid polymer and hydrogen, together with smaller amounts of methane, ethylene, and hexene. J. T.

**961. Near Ultra-Violet Absorption of Pyridine Vapour.** H. Sponer and H. Stücklen. *J. Chem. Phys.*, 1946, **14**, 101.—The absorption spectrum of pyridine at 3000–2500 Å. has been studied in the first order of a 3-m grating spectrograph. Besides carbon ring vibrations the occurrence of hydrogen vibrations is established and discussed. J. T.

**962. A New Approach to the Theory of Relaxing Polymeric Media.** M. S. Green and A. V. Tobolsky. *J. Chem. Phys.*, 1946, **14**, 80.—A molecular theory of relaxing media is presented which gives an expression for the stress in terms of the strain history. At any given time the strain history produces a distribution in internal strains which for mechanical properties can be characterized by a limited number of internal strain parameters. The second law of thermodynamics is used to define dissipation of energy at constant temperature, and explicit expressions for dissipation of energy for any strain history are obtained. Inasmuch as relaxation during straining causes an essential reorganization of structure which is in fact the cause of dissipation, the kinetic theory of elasticity is extended to non-isotropic polymeric networks. A tensor expression for the stress–strain–time relations is thereby developed. J. T.

**963. Stress-Time-Temperature Relations in Polysulphide Rubbers.** M. D. Stern and A. V. Tobolsky. *J. Chem. Phys.*, 1946, **14**, 93.—Polysulphide rubbers of various internal structures have been investigated by measurements of continuous and intermittent relaxation of stress and by creep under constant load at temperatures between 35° C and 120° C. Continuous stress relaxation measurements indicate that these rubbers approximately obey the simple Maxwellian law of relaxation of stress, which indicates that one definite type of bond in the network structure is responsible for stress decay. The activation energy for the relaxation process in each of the polysulphide rubbers is nearly the same, indicating that the same type of bond is responsible for the relaxation behaviour of all the polysulphides investigated. In contrast to the hydrocarbon rubbers, oxygen is not the cause of high-temperature relaxation in polysulphide rubbers, nor does heating in air at moderate temperatures for times comparable to the relaxation time produce changes in physical properties as determined by modulus or by appearance of the samples. Several possibilities regarding the mechanism of the relaxation process and the type of bond involved are considered in the light of the experimental results. J. T.

## Analysis and Testing.

**964. The Determination of Organic Peroxides in Hydrocarbons.** E. M. Tanner and T. F. Brown. *J. Inst. Petrol.*, June 1946, **32** (279), 341–350.—In an attempt to find a method suitable for the estimation of organic peroxides of the type R–O–O–R′ in hydrocarbon oils, several methods of peroxide determination published in the literature were tested. The results obtained were very low, and a method specially suitable for hydrocarbon oils was developed, based on the reduction of the peroxide by ferrous ammonium sulphate in an inert atmosphere and subsequent titration of the excess ferrous salt with standard potassium dichromate solution. The method has also been extended to the determination of peroxides formed in cracked gasolines. A. H. N.

**965. Equation Relating Density. Refractive Index and Mol. Wt. for Paraffins and Naphthenes.** M. R. Lipken and C. C. Martin. *Ind. Eng. Chem. Anal.*, 1946, **18**, 382–382.

The equation derived is $n = \dfrac{69{\cdot}878d - 0{\cdot}4044Ad - 0{\cdot}797A + 135{\cdot}566}{5{\cdot}543d - 0{\cdot}746A + 126{\cdot}683}$

or in an alternative form $d = \dfrac{126{\cdot}683n - 0{\cdot}746An + 0{\cdot}797A - 136{\cdot}566}{-5{\cdot}543n - 0{\cdot}4044A + 69{\cdot}878}$

where $n$ = refractive index at 20° C for the sodium D line, $d$ = density at 20° C, and $A = -10° \times$ temperature coefficient of density derived from the approximate mol. wt. The equation correlates density and refractive index for paraffins, naphthenes, and mixtures of saturated hydrocarbons in the liquid state more accurately than previous equations, and does not require a knowledge of molecular formula or structure. G. R. N.

**966. Analysis for Naphthene Ring in Mixtures of Paraffins and Naphthenes.** M. R. Lipkin, C. C. Martin, and S. S. Kurtz. *Ind. Eng. Chem. Anal.*, 1946, **18**, 376–380.—This paper continues a general investigation of the interrelationship of physical properties and gives a new method based on the temperature coefficient of density and either density or refractive index which is recommended for the analysis of ring content in mixtures of paraffins and naphthenes. When tested on the data for pure compounds the method shows an average deviation of 8%, due mainly to isomer effect. The accuracy of the method is dependent to some extent on the degree of condensation of the naphthene rings, and is unsatisfactory for bridged ring naphthenes and single naphthene rings containing more than 8 carbon atoms in the ring. The method is compared with other methods of ring analysis. The two equations employed take the form :

$$\text{Weight \% ring} = \frac{A + 190{\cdot}0d - 217{\cdot}9}{0{\cdot}593d - 0{\cdot}249} \quad \text{for } d < 0{\cdot}861$$

$$\text{Weight \% ring} = \frac{A + 102{\cdot}8d - 142{\cdot}8}{0{\cdot}262} \quad \text{for } d > 0{\cdot}861$$

where $d$ = density at 20° C and $A = -10^5 \times$ temperature coefficient of density derived from mol. wt. G. R. N.

**967. Simultaneous Determination of Hydrogen Sulphide and Carbon Dioxide in a Continuous Stream of Natural Gas.** C. L. Blohm and F. C. Riesenfeld. *Ind. Eng. Chem. Anal.*, 1946, **18**, 373–376.—Simple laboratory equipment is employed and the two gases are absorbed in standardized barium hydroxide and iodine solutions. The method has an accuracy of the same order as that of other methods, *i.e.*, ± 2·5%. The method is adaptable to routine field testing. G. R. N.

**968. Rapid Test for *iso*Butane Plus an Absorber Residue Gas.** G. M. Liljenstein and W. M. Schaufelberger. *Refiner*, 1946, **25** (4), 129–134.—The new test was developed along the lines of the Butane Weathering test for pentanes + in which a measured vol of the gas is passed through liquid butane at − 44° F and the contacted solvent weathered to a prescribed end point temperature. The *iso*butane + test is carried out at − 110° F and employs liquid propane. A combination of the two methods provides a means for determining the butanes and the pentanes + contents of absorber residue gases. The butanes may be split into *iso*- and normal butane when absorption factor and intake composition data are known. A test may be completed in about 2 hours. It can be used to obtain absorption factor-residue loss curves with which absorber losses can be evaluated over a range of operating conditions. G. R. N.

**969. Estimation of Naphthalene in Absorber Oil.** P. E. Reichardt and D. L. White. *Ind. Eng. Chem. Anal.*, 1946, **18**, 286–288.—Modifications of the general method of volatilization of the naphthalene by means of air from the spent absorber oil are described. These reduce the time of procedure from 15 to 3 hours. The naphthalene is determined as picrate. G. R. N.

**970. Determination of Small Amounts of Aromatic Hydrocarbons in Aqueous Solutions.** H. E. Morris, R. B. Stiles, and W. H. Lane. *Ind. Eng. Chem. Anal.*, 1946, **18**, 294–295.—The aqueous solution is shaken with carbon tetrachloride and after settling the latter is separated and shaken with a sulphuric acid-formaldehyde reagent. The brown colour imparted to the reagent is matched with another portion of the reagent used with an aqueous solution containing a known amount of aromatic hydrocarbon. The determination of small amounts, 1 to 500 parts per million is accurate to ± 10%. The sensitivity is 0·0001 gm of aromatic hydrocarbon. G. R. N.

**971. Determination of Tetraethyllead in Gasoline.** M. V. Sullivan and H. Friedman. *Ind. Eng. Chem. Anal.*, 1946, **18**, 304–306.—A method is described which it is claimed is equivalent in accuracy to chemical analysis and can be completed by an unskilled worker in 5 minutes in which tetraethyllead can be determined in leaded gasoline. Standard deviation was 1% or 0·05 ml/gal of gasoline. The method involves the use of X-ray absorption equipment and a Geiger counter. G. R. N.

**972. A Photographic Viscometric Apparatus.** J. L. Riley and G. W. Seymour. *Ind. Eng. Chem. Anal.*, 1946, **18**, 387–390.—An apparatus is described for the accurate determination of flow times in Ostwald type viscometers. Means of measurement and control of the variables have been designed on the principle of making approximate equal contributions on the final error. A unique feature is the automatic timing device. Motion pictures are made of meniscus transits in the viscometer and of the virtual image of an accurate electronically operated clock. Times of transit are interpolated from the pictures to 0·001 sec. G. R. N.

## Crude Oil.

**973. Crude Oil Desalting.** F. D. Fuqua. *Refiner*, 1946, **25** (4), 140–146.—The salt-removal system described consists essentially of a baffle tube, vertical settler and horizontal settler together with the usual auxiliary equipment. Typical operating data on a paraffinic crude is given and the following observations are made. Best emulsification is obtained with 40 to 50 lb pressure drop across the emulsifying valve.

Temperature within the vertical settler must be maintained for desired emulsion-breaking viscosities (200–220° F); pressure should be sufficient to prevent vaporization (130–150 lb/sq in). Additional contact of water and crude should be induced after lowering the viscosity of the crude. Water should be adequately metered to maintain a constant fresh-water charge for a reasonable brine concentration within the vertical settler (5–15% by vol of crude). G. R. N.

## Gas.

**974. The Picture for Liquefied Petroleum Gases.** G. G. Oberfell and R. W. Thomas. *Oil Gas J.*, 8.6.46, **45** (5), 60.—A review of estimated consumption of liquefied petroleum gases is given.

Large quantities of these gases were used during the war for production of aviation gasoline and synthetic rubber components; and important present markets include with these motor gasoline blending, refining processes, chemicals, carbon black, and plant fuel. For example, between 2 and 4 million gal/day of $C_4$'s will be required for motor fuel and aviation blends, and 700,000 gal for the synthetic rubber industry. As for resources, large volumes will be available from cycling and natural gasoline plants, and extraction from this and other sources may increase average cost of the gases to industry.

Transportation and storage will present problems, and it is estimated that to deliver one tank car per month to a user requires an average investment of $5000. G. A. C.

**975. New Formulations of Aerosols Dispersed by Liquefied Gases.** E. R. McGovran, J. H. Fales, and L. D. Goodhue. *Econ. Entomology*, April 1946, **39** (2), 216.—Tests of various liquefied-gas aerosol formulæ against houseflies and mosquitoes are described.

A large number of formulæ were tested at the Agricultural Research Centre, Beltsville, Md., to serve as a basis for further research. The formulas were tested on houseflies, *Musca domestica* L, and mosquitoes, *Anopheles quadrimaculus* Say, and *Aedes aegypti* L, released in a Peet-Grady chamber.

The aerosol was introduced by the pendulum method, or with a laboratory dispenser or modification. Counts were made 5, 10, and 15 min after release of aerosol, all insects being collected after 15 min observation, placed in recovery cages and mortality counts made next day.

The pyrethrum extract used contained 20% of pyrethrins, the D.D.T. was a purified aerosol grade containing at least 99% of the para-para isomer.

Increasing the sesame oil and non-volatile content, substituting piperonyl *cyclo*hexanone for sesame oil as synergist, and using suitable solvents resulted in greatly improved toxicity of the aerosol formulæ.

When combined with pyrethrum, D.D.T. has some additive effect on knock-down of house-flies, and higher D.D.T. concentrations increased effectiveness against mosquitoes, but the pyrethrum is the primary lethal factor.

Formulations in Freon, with *cyclo*hexanone, lubricating oil, deodorized kerosine, pentanes, an aromatic petroleum solvent, xylene and methylene chloride gave high toxicity against mosquitoes and house-flies. Carbon dioxide packed in soda-syphon cartridge-type containers was satisfactory as a propellant. G. A. C.

**976. Conversion of Dry Natural Gas to Liquid Fuels.** R. C. Alden. *World Petrol.*, April 1946, **17** (4), 46.—A review of the Fischer–Tropsch and other processes utilizing dry natural gases is given.

Experiments in progress since 1913 in Germany led to the large-scale production of hydrocarbons by 1933. The first plants were operated at approximately atmospheric pressure, using purified synthesis gas containing two parts of hydrogen to one of carbon monoxide and 10% of inert gases made from coal, coke-oven gas or that produced from the complete gasification of coal or coke with steam and oxygen. All traces of sulphur compounds must be removed. Reaction temperature is about 350–400° F, cobalt promoted with thoria and supported on kieselguhr is the catalyst commonly used. The large quantity of heat liberated in the reaction must be rapidly removed. The products and unconverted gas are separated in conventional cooling apparatus, the unconverted gas, which contains hydrogen, carbon monoxide, methane,

carbon dioxide, small amounts of propane, butane, and the inerts originally present, being re-processed.

By 1936 an improved process operating at 100–150 p.s.i. was in use, giving slightly higher yields of liquid and solid hydrocarbons.

Approximately 1 ton of product is obtained for every 5 tons of bituminous coal used for all purposes.

The highly normal paraffinic nature of Fischer–Tropsch oils makes them valuable as diesel fuels. The gasoline fraction consists mainly of normal olefines and paraffins, with traces of aromatics.

The solid paraffins or waxes range from very hard high-molecular-weight varieties to the softer more common types. In 1933 the plant capacity was 7000 brl/year, 805,000 in 1936, and by 1944 capacity was 5,590,000 brl of various products. Investigations are proceeding in the United States for the development of the process using natural gas. By a typical process natural gas, steam, and oxygen are heated to 1600° F, and reacted at atmospheric pressure, and from 1000 cu. ft of methane it should be possible to obtain 6·5 gal of motor fuel. The cost of raw material is estimated at $0·0024/gal of gasoline. The use of this process to dispose of excess quantities of dry gas in the States is potentially attractive. Compared with coal as the starting material, it is estimated that it is cheaper to produce gasoline from dry natural gas, and the process may be competitive with present refinery methods utilizing crude petroleum. Several American companies are studying the processes, including the Texas Company and the Kellogg Company.

Other methods of converting dry natural gas into liquid fuels are being investigated, including the direct conversion of methane and ethane to liquid fuels by high-temperature pyrolysis, by one step; but yields are considerably lower than those from the Fischer–Tropsch process. Other methods include the direct high-temperature and high-pressure methanation of tar and oils and interaction of methane and carbon monoxide at high pressure. G. A. C.

## Engine Fuels.

**977. Effect of Leaded Fuels on Cobalt-Bearing Exhaust Valve Materials.** Anon. *Oil Gas J.*, 18.5.46, **45** (2), 153.—Alloys containing stated percentages of carbon, silicon, manganese, cobalt, chromium, and tungsten have been used for valves and seats in internal-combustion engines using leaded fuels, and results investigated. Hard-facing alloys containing 1 to 36% cobalt exhibit same resistance to scaling as do similar materials containing 60 to 65%; those with 30 to 36% are as resistant as alloys containing 60% cobalt. The relation of cobalt content to amount of scaling or erosion is the same as when lead-free fuel is used. The effect of carbon content is important, the scaling resistance of chromium steels decreasing with a corresponding increase in carbon content. Tungsten content is a contributing factor.

G. A. C.

## Gas Oil and Fuel Oil.

**978. Socony-Pot Burner Development Handles 25 Gravity Catalytic Oil.** Anon. *Fuel Oil and Oil Heat*, May 1946, **5** (1), 77.—A brief description is given of an improved pot-type burner, developed by the Socony-Vacuum Co, which gives a blue-white flame and high combustion efficiency when operating on straight catalytic fuels. The burner consists of a circular slightly cone-shaped pot casing with an inclined refractory-lined inner bottom, and the oil inlet at its centre. Above this a central baffle-plate is fixed to protect the oil from cracking by the direct heat of the flame, and above this plate a wall baffle is placed, which induces better mixing of the primary air and the oil vapours. Both plate and baffle are fixed at predetermine heights from the oil on the bottom, which allows thorough pre-mixing of the oil vapours and primary air at reasonably low temperatures and permits partial oxidation. At the top of the pot burner casing a series of air ducts causes secondary air to be admitted to assist combustion. Performance curves are discussed, and are given in a table for the original and the improved burners; these show that it is possible to obtain a satisfactory smoke rating with the improved burner at a much lower draft than with the original. The flue gases had a $CO_2$ content of 11·8% and 14% at low and high fire, respectively. The smoke ratings are described; they were made by means of an ICHAM instrument, developed for the purpose. W. H. C.

## Lubricants.

**979. Viscosity of Oils.** W. L. Nelson. *Oil Gas J.*, 18.5.46, **45** (2), 163.—No. 93 in the *Refiner's Notebook* series illustrates, by means of a table and graph, a method of determining the viscosity index of an oil from its viscosity at a stated temperature in conjunction with the A.P.I. gravity. G. A. C.

**980. The Development of Improved Turbine Oils.** C. N. Smith and G. H. S. Snyder. *J. Inst. Petrol.*, June 1946, **32** (279), 313–322.—The need to inhibit oxidation in turbine oils was met by using antioxidants, but these in turn produced a problem. Rusting of metal surfaces was apparently inhibited by the oxidation products of the oils, and thus, by reducing oxidation, rusting was enhanced. Rust-inhibited turbine oils had to be developed. Thus a need for adequately testing turbine oils for oxidation and rust inhibition arose. These methods of testing are discussed in the paper. Field tests of turbine oils are also briefly discussed. A. H. N.

**981. Acryloid 150—Pour Point Improver.** Anon. *Oil Gas J.*, 20.4.46, **44** (50), 142.—A new synthetic pour-point depressant developed by Rohm & Haas, Philadelphia, is also claimed to raise the VI of a lubricating oil. Its composition is not disclosed, but it is probably a polymer, copolymer, or condensation product of some type, possibly an acrylic-acid derivative. Supplied in a relatively viscous form, 1·25% added to an oil of pour point + 20° F, lowered this to − 25° F while raising the VI from 114 to 130. I. W. E.

**982. Syntho Lubes from Ethylene Condensation.** H. Schildwachter. *Refiner*, 1946, **25** (3), 109–113.—Condensation of ethylene with coal-tar fractions, naphthalene, and tetralin gives good yields of satisfactory lubricants. The viscosity of these synthetic oils can be increased further by treatment with the silent electric discharge. The oils show good stability under heat, are free of asphalt and potential sludge components, and do not form tars during oxidation at 120° C. Even after electrical treatment these oils have a low V.I., but this can be overcome by the addition of voltolized fatty oils. G. R. N.

**983. "Ucon" Synthetic Lubricants in the U.S.A.** Anon. *Petrol. Times*, 22.6.46, **50** (1276), 633–634.—These oils have, until recently, been on the secret list. They were produced by Carbide and Carbon Chemicals Corpn. as synthetical compounds

TABLE I.

*LB Series "Ucon" Synthetic Lubricants.*

| Grade. | LB-140. | LB-300. | LB-400. | LB-550. | LB-650. |
|---|---|---|---|---|---|
| Sp. gr. at 60° F. | 0·983 | 0·997 | 1·001 | 1·003 | 1·004 |
| Flash point, ° F. | 440 | 470 | 485 | 510 | 525 |
| Fire Point, ° F. | 510 | 570 | 580 | 580 | 580 |
| Saybolt viscosity— | | | | | |
| Univ. secs. at 210° F. | 45·5 | 62·7 | 74·3 | 91·9 | 107 |
| 100° F. | 140 | 300 | 400 | 550 | 650 |
| 0° F. | 4,960 | 18,380 | 27,600 | 40,800 | 50,500 |
| −30° F. | 42,100 | 183,000 | 284,000 | 444,000 | — |
| −50° F. | 265,000 | — | — | — | — |
| Kinematic viscosity— | | | | | |
| Centistokes at 210° F. | 5·9 | 11 | 14·1 | 18·1 | 22 |
| 100° F. | 29·8 | 65 | 86·6 | 119 | 141 |
| 0° F. | 1,080 | 4,000 | 6,000 | 8,900 | 11,000 |
| −30° F. | 9,200 | 40,000 | 62,000 | 97,000 | — |
| −50° F. | 58,000 | — | — | — | — |
| Viscosity index | 147 | 142 | 142 | 140 | 140 |
| Pour point, ° F. | −50 | −40 | −35 | −30 | −25 |
| Conradson carbon residue % | ← Less than 0·01 → | | | | |
| Ash % | ← Less than 0·01 → | | | | |

which contain no petroleum base. At present there are two series under manufacture, the "LB" series being essentially insoluble in water, and the "50-HB" series, being soluble in water at room temperature; of these the LB series is of prime interest, having been applied to lubrication of internal combustion engines on land and in the air. The general properties of the LB series are reproduced in Table I.

The manufacturing process is undisclosed, but it is claimed that wide ranges in viscosities are attainable by controlling manufacturing variables.

There is some difficulty in applying present-day classification standards to these synthetic oils. A. H. N.

**984. Secrets of German Lubricating Oil Technology Revealed.** Part III. C. I. Kelly. *Petrol. Times*, 8.6.46, **50** (1275), 566.—Whilst it describes the Germans' approach to the designing and manufacturing of hydrocarbons with molecular structures, and properties conforming to their concepts of an ideal lubricating oil—an American expert's appraisal stresses the degree of practical success attained—there is in this review a brief historical survey of advances in the separation and identification of classes of hydrocarbons in mineral lubricating oils. The reviewer makes it evident that a fuller understanding of hydrocarbon molecular structures and properties has been and is being energetically sought, so that it may be known more definitely which hydrocarbons should, during refining, be left in the finished products. It emerges from this review of CIOS, BIOS, and FIAT Reports, both informative and interesting in this matter, that the Germans have not altogether disclosed the fundamental data on the many branched-chain paraffinic hydrocarbons synthesized and later reproduced on a large scale in Germany during the war. A conclusion is reached that in addition to the existing need for their filling of many other gaps in their information, the Germans should release for early publication the properties of these synthesized hydrocarbons which with proved molecular structure are almost in a class of their own, not previously extensively explored. Thus can the value of invisible reparations be increased and a speedier solution of current problems, in the sphere of identification and more profitable separation of hydrocarbons in petroleum lubricating oils, be facilitated. A. H. N.

**985. Secrets of German Lubricating Oil Technology Revealed.** Part IV. C. I. Kelly. *Petrol. Times*, 22.6.46, **50** (1276), 655.—In this part the ester oils developed by I.G. are studied in detail. The general attitude adopted against the use of fatty oils in Germany, Britain, and U.S.A. is noted. In a search for materials with "oiliness" oxygenated compounds were studied, and, of these, the esters in particular. Of the esters examined during a long programme of research, the following are some examples:

TABLE I.

*Properties of Some Synthetic Ester-Lubricating Oils.*

| Organic acid. | Adipic. | Beta Methyl-adipic. | Sebacic. | Mixed Cymono-carboxylic acids. |
|---|---|---|---|---|
| Alcohol. | Iso- and normal octyl.* | Normal octyl. | Iso-octyl. | Trimethylol-ethane. |
| Density at 68° F. | 0·922 | 0·920 | 0·912 | 0·958 |
| Viscosity, Saybolt— | | | | |
| Univ. secs. at 122° F. | 45·5 | 48 | 54 | 62 |
| 100° F. | 50 | 55 | 65 | 81 |
| Viscosity index | 191 | 228 | 189 | 157 |
| Pour point, ° F. | −11 | −33 | below −98 | −94 |
| Flash point, ° F. | 405 | 440 | 445 | 465 |

* Half ester of each alcohol.

Some of these properties are misleading, *e.g.*, although the V.I. is high, the blending V.I. of these compounds does not seem to be so high. The ideal ester is found to be a simple one of straight, thin, unbranched chains. The manufacturing process of commercial esters is described. A. H. N.

**986. Heat of Wetting of Metal Surfaces by Oils.** H. H. Herbst. *Refiner*, 1946, **25** (3), 12–25.—The heat of wetting of oils on metallic surfaces is proportional to the lubricity of the oil. The heat rise is small when measured on a straight metal surface, so finely divided metallic powders have been employed to assess this property. This has the disadvantage that the true surface area is not well defined, so that certain adsorption concepts must be taken into account. The author shows capillary structure, and ultra-porosity exerts considerable influence, and to overcome the unknown effect of these variables describes an apparatus wherein the heat of wetting is carried out directly on the smooth metal or bearing metal itself. G. R. N.

**987. Phemenbria in the Oil Insulation of Pressurized Electric Cables.** C. F. Proos. *Ingenieur*, 1946, **58**, E 27–37.—A series of full-scale experiments on a 300-ft length of pressurized cable is described. The cable was insulated with oil impregnated paper, the insulation being maintained under pressure. The oil is not specified.

The effect of variations in temperature (range 2° to 50° C) and voltage (range 0 to 175 kV) on loss factor (tg. $\delta$) has been measured. Additional data were collected on the copper distribution throughout the paper insulation in the aged cable, and the insulating properties of the oil recovered from the various layers of the paper wrapping. Spreading measurements on the recovered oil using an oil–water interphase yielded information on the presence of polar (oxidation) products in the aged oil. These spreading measurements appeared to be very sensitive, and were capable of indicating changes before the electrical properties were affected.

The deterioration of the electric insulation during use is ascribed to the presence of polar decomposition products dispersed in the oil phase. Under the influence of the electric field, these polar bodies are deposited on the paper, thereby aggravating the dielectric losses. M. B.

**988. Practical Experiences with Sleeve Bearings of High-Speed (Diesel) Engines.** F. C. van Asperen. *Ingenieur*, 1946, **58**, W. 1–5.—A general discussion of the effect of temperature on wear and " life " of white-metal sleeve bearings, gudgeon pins, and crankshafts based on results obtained during the running-in of new high-speed Werkspoor diesel engines. The importance of the cooling function of luboil is stressed and some data are presented on bearing temperatures and oil temperatures as a function of load and operating time, together with some previously published data by C. G. Williams (General Discussion of Lubrication, London, 1937). M. B.

**989. Bearing Corrosion.** Part 2. H. H. Zuidema. *Oil Gas J.*, 23.2.46, **44** (42), 151.—Laboratory tests indicate that bearing metals differ widely in their resistance to corrosion. In particular experiments carried out by the Underwood, the Existent Corrosivity and the Thrust Bearing Corrosion tests show certain trends which agree well with engine tests. The babbitts were practically inert in these tests, while Cu–Pb, Cd–Ag, and Cd–Ni were attacked in increasing order.

Corrosion can be reduced by covering the metal surface with another metal or alloy, such as the indium plating of cadmium–silver, or by the addition of a small amount of another metal in the bearing alloy.

Bearing corrosion may be of three types :—

(1) Acid corrosion by far the most prevalent, and involving the solution by acid of a metal relatively high in the electromotive series.

(2) " Sulphur " corrosion particularly serious with silver bearings and the copper matrix of Cu–Pb.

(3) Corrosion by aqueous acids, which occurs with low temperatures and insufficient venting again affecting mainly copper.

The paper includes as an appendix a summary of the compounds claimed in U.S. Patents as bearing corrosion inhibitors. D. L. S.

**990. Bearing Corrosion.** Part 3. H. H. Zuidema. *Oil Gas J.*, 2.3.46, **44** (43), 66.—Corrosion of a given bearing alloy is determined by the following ten factors, half of which are engine and the rest oil factors.

(1) *Temperature* affects corrosion principally through its effect on the rate of oxidation of the lubricating oil, which is approximately doubled for each 10° C rise. In addition, there may be a mechanical factor, since the hardness of bearing alloys decreases with temperature and weight losses due to abrasion may be more serious at higher temperatures.

(2) *Bearing load* is in general not critical. Variation in thrust from 15 to 125 p.s.i. has comparatively little effect on corrosion in the T.B.C. apparatus.

(3) *Venting* can affect corrosion in two ways operating in opposite directions. Increased air flow increases oxidation rate, and thus increases the rate of formation of corrosive acids. However, venting removes the more volatile acids, so that the net effect depends on the relative importance of the two factors.

(4) *Type of fuel* is of importance when considering corrosion. Thus acids produced by the fuel may be corrosive, while the lacquer depositing tendencies of unstable fuels must also be considered. Decomposition products of TEL can form iron halides which are powerful catalysts for the oxidation of oil.

(5) *Oxidation stability of the lubricant* naturally controls the formation of corrosive oxidation products.

(6) *Type of deterioration products formed in lubricant* is of great importance, since these products can vary from inert to highly active substances.

(7) *Detergency.* Detergent oils tend to remove lacquer films from the bearings, leaving the surfaces bare and vulnerable to attack by acids.

(8) *Passivation of bearing surfaces* can best be achieved by incorporating a compound in the oil capable of forming a protective film on these surfaces.

(9) *Action of sulphur* can be harmful if the sulphide film formed, *e.g.*, with copper in Cu–Pb bearings flakes off as hard, brittle particles.

(10) *Presence of water* may increase the corrosive effect of acid deterioration products, which in solution in water form highly corrosive solutions.

Four principal means of controlling corrosion are suggested: (*a*) Use of new bearing types, *e.g.*, sandwich type or indium treated bearings; (*b*) Operation of engines at lower temperatures; (*c*) Selection of suitable lubricants; (*d*) Use of suitable inhibitors. D. L. S.

## Bitumen, Asphalt and Tar.

**991. Behaviour of Asphalts in Thin-Film Oven Test.** R. H. Lewis and W. J. Halstead. *Public Roads*, April–May–June 1946, **24** (8), 220.—Information on the behaviour of 60–70, 100–120, and 120–150 penetration grades of asphalts in the thin-film test is presented.

Seventeen asphalts from various sources, which had been stored in unopened metal containers for 6 years, were used in the work; the top ¼-inch being removed, and the balance liquefied. Tests on both were made, and showed surface hardening, but no appreciable change had occurred in the bulk of the material for most samples. For the remaining study, specific gravity, softening point, penetration, and ductility figures were determined on the original asphalt and on residue after the oven test. Tabulated results show little significance in the amount of change in weight of the samples; the percentage of original penetration retained by the residue from the oven test shows a tendency to decrease with increases in original penetration, but there are deviations. The percentage increase in softening point of the residue as compared with that of the original material tends to increase as the percentage of retained penetration decreases. When compared at the same penetration, residues from thin-film oven test have lower ductility than the original asphalt. Among a number of conclusions based on these results are that for asphalts from the same base and process, the relation of the ductility to penetration is the same for all penetration grades, regardless of the temperature at which a given penetration occurs, and the ductilities of the thin-film oven test residues show a common relation to penetration that is different from the relation for the original asphalt.

Specification requirements regarding loss in weight and penetration of residue are suitable for all asphalts from 50–60 to 120–150 grades. G. A. C.

## Special Hydrocarbon Products.

**992. Production of Toluene from Petroleum.** D. A. Howes. *Industr. Chem.*, 1946, **22**, 403–413.—After a brief historical review, the author traces the development of modern methods for the production of toluene from petroleum. The methods considered are superfractionation, azeotropic distillation, extractive distillation, hydroforming, cyclization. F. S. A.

## Derived Chemical Products.

**993. By-Products of Oil Refining.** Anon. *Paint Technology*, March 1946, **11** (123), 113.—U.S. Patents 185,951–2 and No. 2,247,411, granted to F. Rostler, V. Mehner, and L. Bornstein, relate, respectively, to the methods of recovery of waste hydrocarbon materials from acid sludges or the residues from solvent refining, and the use of the product as a constituent of varnish resins. The recovered hydrocarbon material is generally a red-brown viscous fluid resinous material with a greenish fluorescence; it is slightly unsaturated and has a molecular weight of from 400 to 1000. It is soluble in most organic solvents and in concentrated sulphuric acid, and is capable of polymerization, condensation, and is reactive with concentrated, though not dilute, reagents. Sulphur produces an effect similar to the vulcanization of rubber. As constituents of resinous condensates, these petroleum by-products are said to have a plasticizing effect, increasing fluidity without much affecting the hardening time. Stoving finishes made from such are said to have electrical properties and high resistance to fatty oils, acids, and water. With linseed oil good varnishes are formed, similar to those formerly based exclusively on tung oil. When the amount of hydrocarbon material is relatively large, the linseed oil appears to act as a softener. Descriptions are given of the condensation of the hydrocarbon material with formaldehyde, cresols, and ammonia in the production of resinous condensates. The characteristics of the condensation products, and the production of stoving finishes from them by the addition of alcohol–benzene mixtures, methyl*cyclo*hexanol or acetone, and of a transparent wire-enamelling (insulating) varnish, are briefly noted. W. H. C.

**994. Hydrocarbon Drying Oils.** *Paint Technology*, April 1946, **11** (124), 150.—U.S. Patent 2,258,821, granted to the Standard Oil Co., H. M. Steininger and R. J. Diwoky, relates to certain fractions derived from naphtha reformer tars, from reforming operations which are highly satisfactory as drying oils. The drying characteristics of the fractions increasing with the severity of the reforming conditions. Suitable fractions are those having Saybolt viscosities of 35–100 sec at 100° F and Nanus iodine values from 75–100. Similar products may also be obtained from the tars by extraction with solvents having a selective affinity for unsaturated compounds. W. H. C.

**995. Processes for Making Nitrile Compounds Patented by Three Oil Companies.** D. P. Thornton. *Nat. Petrol. News*, 6.3.46, **38** (10), R-221.—Claims in a number of patents for the production of nitrile compounds are reviewed.

Amines, nitriles, and their derivatives have uses as addition agents in lubricants, fuels, synthetic rubber, plastics, and as an intermediate for further chemical synthesis. A number of patents have been taken out for the production of these compounds by the major oil companies.

A Phillips patent discloses the manufacture of acrylonitrile from methane or ethane, and ammonia, the first step being pyrolysis in the range 1300 to 1500° C at a pressure of 200 mm. of mercury, followed by a catalytic treatment of the cooled gases. Catalysts used include sodium cyanide, contained in a conventional solid bed. Products leaving the catalyst chamber include acrylonitrile, hydrogen, and methane, and after a water quench the nitrile is removed by fractional distillation.

A Shell patent uses unsaturated allyl amines, and is based on catalytic oxidation in the presence of metallic silver or copper, yields of 72 to 89% being reported. The process requires continuous, intermittent or batch vapour-phase reaction at 450 to 600° C at atmospheric pressure.

Separation of the nitrile is dependent on nature of diluent used, but when this is steam, the gases are condensed.

A method of protecting unsaturated nitriles from autopolymerization during storage by using an alpha beta unsaturated amine is given in Shell's patent.

Five patents have been taken out by Sinclair covering preparation of amines and nitriles by direct catalytic reaction of the corresponding olefin hydrocarbons with ammonia. The process may operate either as a batch type, intermittently or in a continuous manner. Optimum reaction temperature is from 500 to 600° F under pressure of 2000 p.s.i., polymerization of the olefinic charge being promoted by high temperatures. Equipment required includes a pump, reactor, cooler, and product receiver.

One patent (2,381,473) deals with the preparation and demonstration of efficiency of cobalt-on-silica catalysts, promoted with manganous oxide. G. A. C.

## Miscellaneous Products.

**996. D.D.T. to Control Hornflies and Gulf Coast Ticks on Range Cattle in Florida.** J. G. Matthysse. *Econ. Entomology*, Feb. 1946, **39** (1), 62.—Results of using six different methods of spraying cattle for control of hornflies are reviewed.

Methods included complete and incomplete spraying, either as cattle were held in a chute as they ran from the pen or through a bank of nozzles arranged around the inside of the chute. Dipping of cattle was also employed.

The severe conditions of southern Florida made it necessary to use higher concentrations of D.D.T. than were used previously in other areas. Sprays at from 0·1 to 0·2% gave deposits that were effective against hornflies for less than a week; concentration of emulsions had to be raised to 2·5% D.D.T. to get 10 days effective deposit, but 1% concentration of suspensions gave 2 weeks effective results. Suspension at all concentrations gave longer lasting deposits than emulsions.

Dips were more effective at a given concentration than spray suspensions, but were uneconomical, as over a gallon per head was taken out of the 2000-gal vat, which itself has to be charged with D.D.T., whilst spraying required less than 1 qt.

Rainfall was found to have a definite effect, a dry spell resulting in longer acting deposits.

Method of spraying was found to have no signifiant effect on control.

Gulf Coast tick, *Amblyomma Maculatum Koch*, was controlled by inclusion of D.D.T. in adhesive sprays and greases applied to the ears of the cattle, thus reducing the incidence of screw-worms which would otherwise have developed in the wounds caused by the ticks. G. A. C.

**997. D.D.T. Residual-Type Sprays as Affected by Light.** A. W. Lindquist, H. A. Jones, and A. H. Madden. *Econ. Entomology*, Feb. 1946, **39** (1), 55.—Tests to determine the effect of exposure to ultra-violet light and sunlight on the residual properties of D.D.T. have been carried out at Orlando, Florida. Plywood boards, glass petri dishes, and flat glass plates were sprayed with D.D.T. solutions, emulsions, and suspensions so that the concentration was 200 mg of D.D.T. sq. ft. Duplicate treatments were unexposed as check. Exposed and unexposed residual deposits were tested against houseflies, *Musca domestica* L, the time to obtain 50% knock down being determined. Various periods of exposures were given in several series of tests, and the effects are given in tables. Exposure to both ultra-violet light and sunlight reduced the effectiveness of the treatments in most cases; the loss being greatest when high-boiling solvents were used. The results show that D.D.T. is more rapidly and completely decomposed in solution than as a solid deposit, comparatively dry deposits that form from suspensions and emulsions showing least decomposition. G. A. C.

**998. D.D.T. Emulsion Applied to Rice-Field Water to Control Mosquitoes.** C. B. Wisecup, W. O. Brothers, P. M. Eide, and C. C. Deonier. *Econ. Entomology*, Feb. 1946, **39** (1), 52.—Experimental methods and results of the application of emulsions containing D.D.T. to control mosquitoes in rice-fields are discussed.

The flooding and drying operations necessary in the cultivation of the rice-fields of Arkansas provide ideal conditions for the mosquitoes of the species *Psorophora, confinnis, P. discolor, P. ciliata*, and of *Anopheles quadrimaculus*. Tests were made employing a basic concentrate of 20% D.D.T., 20% Triton X-100 (an aralkyl poly-

ether alcohol) as the emulsifying agent, and 60% of xylene as solvent, the concentrate being diluted with water to form emulsions of from 1 to 10% D.D.T. concentration. This emulsion was applied to the flowing irrigation waters at the wells, 16 treatments being made on 10 fields using a drip can filled with a metering valve. Weekly dipping records were obtained, at least 10 dips from each flooded contour. From data given in the table it is evident that the degree of contol in a field was affected by: (*a*) the concentration of D.D.T. emulsion in the water; (*b*) the dosage of D.D.T. applied; (*c*) the distance that the emulsion was carried in canals before it entered the field; and (*d*) the size of the field.

The method is suitable for controlling mosquitoes in fields up to 70 acres in extent where the irrigation flow is about 1000 gal/min, using about 1 part of D.D.T. per million parts of water, applied where the waters enter the field.

No damage occurred to the current rice crop (1944). More satisfactory equipment for applying the emulsion has yet to be found, the conventional types of drip cans being unsuitable. G. A. C.

**999. Mineral Oil Films in Relation to Mosquito Control.** A Crosafield and G. F. Hazzard. *J. Inst. Petrol.*, June 1946, **32** (270), 323–340.—The physics of spreading is briefly outlined, followed by considerations of laboratory and field studies of spreading oils. It is concluded that the field requirements of such materials comprise: (1) an oil with a low viscosity for rapid penetration of tracheæ of larvæ. However, the lower the viscosity the more volatile the oil, and thus the less the film stability and durability; (2) The spreading pressure should be high in order to produce more complete spread over contaminated surfaces and films more stable to wind and mechanical displacement under field conditions. In contrast, as increase of spreading pressure gives a decrease in toxicity under laboratory conditions; (3) Use of a highly aromatic oil or a cracked material such as P.D. bottoms, gives a highly toxic oil. However, film stability is poor with aromatic fractions, and with P.D. bottoms rapid oxidation and polymerization may occur in the field to give incomplete films.

In general, no field experiments have indicated a correlation between the laboratory film stability test and field conditions. Because the effect of evaporation is so pronounced any conclusions from laboratory observations should be treated with caution. A. H. N.

**1000. Disposal of Petroleum Refinery Wastes.** (Article 3.) W. B. Hart. *Nat. Petrol. News*, 6.3.46, **38** ((10), R-225.—Refinery wastes as a factor in soil conservation are discussed.

The use of water for domestic supply takes precedence over any other use of water. Many cities take their supplies from local streams and lakes, and it is important that these are not polluted by refinery wastes, which can seriously impair surface-water quality, which is important to both industrial development and inhabitants of the locality.

Irrigation is a most important use of water in the western part of U.S.A., and such water is taken from many sources, including relatively small streams whose value can be destroyed by refinery wastes.

Certain refineries can so pollute small streams that serious damage is done to fish, and the valuable recreational value of surface waters greatly diminished.

Untreated refinery wastes can kill all forms of animal and vegetable life, and when the bank or shoal vegetation is destroyed, erosion sets in, banks are undermined, and collapse and indentations develop. Eventually the erosion spreads over wide areas, drainage paths are choked, and floods follow. Conservation, that is, treatment of refinery wastes, will correct this. G. A. C.

**1001. Secrets of German Fuel Technology Unearthed.** Anon. *Petrol. Times*, 8.6.46, **50** (1275), 579.—The following CIOS, BIOS, and FIAT Reports are briefly reviewed:

CIOS VI–22, X–18 and 22, XV–5. The Fischer–Tropsch Process (28 pages). H.M.S.O., 2*s*. 6*d*. (post 2*d*.).

CIOS XXXI–58. Compilation of German Fuels and Lubricants Specifications (29 pages). H.M.S.O., 2*s*. 6*d*. (post 2*d*.).

CIOS XXXI–85. Edeleanu G.m.b.H., Altenburg (73 pages). H.M.S.O., 6*s.* 6*d.* (post 3*d.*).
CIOS XXXIII–30. Sticksloffwerk–Hibernia Wanne–Eickel–Ruhr: Recovery of Hydrocarbons from the Coke-Oven Gas (6 pages).
CIOS XXIII–15. I.G. Farbenindustrie A.G., Frankfurt/Maia (30 pages). H.M.S.O., 2*s.* 6*d.* (post 1*d.*)
BIOS–332. Chemische Fabrik Weyl A.G., Mannheim-Waldhof (8 pages). H.M.S.O., 1*s.* 6*d.* (post 2*d.*).
BIOS–197. Reichinstitut fur Erdolforschung Technische Hochschule, Hannover (7 pages). H.M.S.O. 1*s.* (post 1*d.*).
BIOS–351. Preparation of Adipic Acid from Tetrahydrofuran and Carbon Monoxide (3 pages). H.M.S.O., 6*d.* (post 1*d.*).
BIOS–330. Wirtschaftliche Forschunges m.b.H. (WIFO) Eickeloh Installation (11 pages and 3 plates). H.M.S.O., 1*s.* 6*d.* (post 2*d.*).
BIOS–447. Interrogation of Dr. Otto Roelen of Ruhrchemie A.G. (63 pages).
BIOS–336. Metallgesellschaft A.G. and the Lurgi Group of Chemical Engineering Companies (210 pages). H.M.S.O., 20*s.* (post 5*d.*).
BIOS–373. I.G. Farbenindustrie A.G. Ludwigshafen (Fuels and Lubricants) (140 pages). H.M.S.O., 14*s.* 6*d.* (post 4*d.*).
BIOS–326. Interrogation of A. Bollhorn, E. Grages and Dr. Gross of Deutsche Erdol A.G., Berlin (29 pages). H.M.S.O., 3*s.* (post 2*d.*).
BIOS–450. Gesellschaft fur Teerverwertung m.b.H. Duisberg-Meiderich and Castrop-Rauxel (55 pages).
FIAT–62. I.G. Work on Polyamides I.G. Farben. Ludwigshaven (3 pages) H.M.S.O., 6*d.* (post 1*d.*). A. H. N.

**1002. Secrets of German Technology Unearthed.** Anon. *Petrol. Times*, 22.6.46, 50 (1276), 660–661.—The following CIOS, BIOS and FIAT Reports are reviewed:

CIOS XXII–15. I.G. Farbenindustrie Plant, Frose, Germany (2 pages). H.M.S.O., 6*d.* (post 1*d.*).
CIOS XXIII–16. Oil Targets in Ruhr and Hanover Areas (23 pages).
BIOS Final Report No. 137 (Appendix)—*cyclo*Polyolefines (Paper by Dr. J. W. Reppe, I.G. Farben. Research Chemist) (18 pages). H.M.S.O., 2*s.* (post 1*d.*).
FIAT–422. Manufacture and Regeneration of Catalysts at I.G. Farbenindustrie, Ludwigshaven-Oppau (9 pages and 4 charts).
FIAT–239. Fischer–Tropsch Plant of Hoesch Benzin A.G. at Dortmund, Germany (3 pages).
FIAT–368. Interrogation of Dr. Gunter Spengler, Munich, formerly of Institute for Coal Research, German Technical High School, Prague (26 pages).
FIAT–426. Interrogation of Dr. Pier and Staff of I.G. Farbenindustrie, A.G. Ludwigshafen/Oppau (29 pages). H.M.S.O., 4*s.* (post 2*d.*).
FIAT–483. Polymerization of Ethylene (28 pages). H.M.S.O., 2*s.* 6*d.* (post 2*d.*).
FIAT–423. Synthetic Lubricating Oil Manufacture, Rhenania-Ossag Mineralowerke A.G. Harburg Refinery (6 pages).
FIAT–293. I.G. Farbenindustrie–Leverkuson, Germany (11 pages).
A. H. N.

**1003. United Kingdom Petroleum Imports and Exports.** Anon. *Petrol. Times*, 8.6.46, 50 (1275), 582–583.—Statistics are presented for April and the four months combined.
A. H. N.

## Engines and Automotive Equipment.

**1004. Transonic Research.** Anon. *Flight*, 11.7.46, 50 (1959), 36.—The article gives details of the Vickers rocket-propelled model for investigating sonic speed flight. Power is supplied by a bi-fuel rocket, the fuels being 7½ gal of C-Stoff (57% methyl-alcohol, 30% hydrazine-hydrate, and 13% water) and 12 gal of T-Stoff (approx. 80% hydrogen-peroxide and 20% water), which are carried in three cast-steel tanks, and are fed to the combustion chamber by compressed air stored at 515 lb/sq. in. in three toroidal bottles, the air being delivered to the tanks through a reducing valve.

The C-Stoff and T-Stoff are piped to three equi-spaced, radially disposed injector nozzles in the combustion chamber end-wall, the C-Stoff being injected axially, with the T-Stoff injected co-axially surrounding it. When these two liquids come together, spontaneous combustion takes place, but the exact proportion of the fuels and the degree of atomisation are extremely critical in their effect on performance. The theoretical optimum fuel ratio is 0·36 T-Stoff to 1·0 of C-Stoff (by weight), but the actual ratio achieved is about 0·3 : 1·0. Actual temperature rise is 1750° C, and the specific thrust attained 180 lb/lb fluid/sec. Fuel consumption is 17·2 lb/hr/lb thrust, and for the fuel carried, this gives a total thrust of 800 lb. I. G. B.

**1005. Jet Propulsion.** J. G. Slotboom. *Ingenieur*, 1946, **58**, L 17–23.—On the basis of a mathematical analysis of propelling power, power output, efficiency, and specific fuel consumption, it becomes possible to evaluate various types of jet engines operating under different conditions.

It appears that in the available forms of jet engine the specific fuel consumption is higher than the theoretical figure, possibly because of poor compressor efficiency or low compression ratio. M. B.

**1006. Evolution of Energy for Jet and Rocket Propulsion.** P. Bielkowicz. *Aircraft Engng*, April 1946, **18** (206), 129.—This article is continued from p. 92, and deals with the specific heat of gases and the determination of nominal temperatures in a combustion chamber. An outline of modern specific heat theory is given showing the effects of temperature and pressure on the gas properties. Comparisons are made between three sources of empirical data (Lewis and Randall, *Technical Data on Fuel and Schüle*), on molecular heat at constant pressure and disturbingly large divergences are obvious.

The determination of the nominal temperature in a combustion chamber is made on the assumption of no dissociation and no radiation loss. A simple example of the complete combustion of ethyl alcohol in pure oxygen is taken. The article is to be continued. I. G. B.

**1007. Notes on the De Havilland Goblin Jet Engine.** Anon. *Aircraft Engng*, April 1946, **18** (206), 126.—The description given is one of a series following the historical record of jet-engine design. The notes on each component of the engine are informative. Leading particulars of the Goblin II are as follows:

| | |
|---|---|
| Diameter, max. | 49·85 inch |
| Length, overall | 100·5 inch |
| Weight, bare | 1342 lb |
| engine accessories | 68 lb |
| airframe „ | 80 lb |
| exhaust cone, etc. | 140 lb |
| Total dry weight | 1630 lb |
| Fuel | aviation kerosine (R.D.E./F/Ker + 1% lubricating oil (D.E.D. 2472 B/O) |
| Oil | Intava 620 |
| Capacity | 1·5 gal |

| *Rating* | *Static Thrust* |
|---|---|
| Take-off and combat | 3000 lb. at 10,200 r.p.m. |
| Climb | 2610 „ „ 9,700 „ |
| Cruising | 1920 „ „ 8,700 „ |
| Idling | 195 „ „ 3,000 „ |

I. G. B.

**1008. Two New Power Units.** Anon. *Flight*, 25.7.46, **50** (1961), 99.—Latest of the Napier Sabre piston engine range, the Mk. VII, is distinguished in having provision for water/methanol injection. In the Tempest installation 28 gal of 60/40% methanol-water mixture is carried in one wing and is delivered by a Plessey motor and pump unit. A Napier air separator has also been developed for the system.

The engine has fuel injection into the eye of the supercharger impellor, and the anti-detonant fluid is injected from a shroud around the fuel-supply nozzle. Maximum delivery is at the rate of 200 gal/hr, and the normal proportion of water/methanol mixture to fuel is 45 : 55% in F.S. gear and 30 : 70% in M.S. gear.

Possibly due to the sleeve valves and their effect on combustion efficiency, Sabres have always given little or no exhaust flame. Mk. VII is now fitted with 12 individual stub pipes on each side. Data for the engine are as follows :—

Capacity 36·8 litres : Output 83 b.h.p./litre.

Weight 2500 lb : Spec. weight 0·83 lb/b.h.p.

Max. power with water/methanol injection 3050 b.h.p. at 3850 r.p.m. + 17½ lb boost. I. G. B.

**1009. The Evolution of Energy in Jet and Rocket Propulsion.** P. Bielkowicz. *Aircraft Engng*, April 1946, **18** (207), 163.—Continued from p. 132, the author deals with the mechanism of dissociation. The first part deals concisely with the physical processes and the mathematical formulæ used to describe these processes. Values of the dissociation constants are given at various temperature levels, and it is shown that high-combustion temperatures involve greater degrees of dissociation, whilst high pressures have the opposite effect. In the second part practical use is made of the formulæ established, and water vapour and carbon dioxide were taken as examples. The presence of an inert gas does not change the behaviour of the gases examined, whose partial pressures will remain the same. An example is given of the dissociation of $CO_2$ in an atmosphere of nitrogen, which may occur in a jet-propelled engine with air supply. Also investigated is the dissociation of a mixture of two active gases, having a common product of dissociation. The case is exemplified by the mixture represented by the general formula, $aCO_2 + bH_2O$. I. G. B.

## MISCELLANEOUS.

**1010. International Petroleum Outlook in Relation to Operations in the United States.** C. O. Willson. *Oil Gas J.*, 8.6.46, **45** (5), 65.—The production, consumption and transportation position of the world oil business is summarized.

Although hostilities have ceased, world production and consumption of petroleum is similar to that at peak period of the war, and total military needs will be much greater than they were pre-war, and for an indefinite period. Reconstruction in the war-devastated areas is largely centred on petroleum, and other outlets have expanded so that 40% more crude oils is consumed now than pre-war.

A table showing world crude oil output and reserves (excluding Russia) indicates that greatest increase in world production has been in the U.S.A., Venezuela, and the Middle East; and most of the world's reserves (excluding Russia) are in those areas. It is not expected that the U.S.S.R. will be an important factor in world markets in the near future.

The ownership of the world's oil is vested in the United States, British, or British-Dutch interests.

Available reports on demand show that the United States has accounted for the bulk of the world consumption, but some time will elapse before accurate estimates can be made of the world situation in this respect.

A table giving 1939 consumption shows that the next largest off-take was in Europe—viz., 23·2%, about a third of the United States figures. Future outlook is to Western Europe for increased demands.

With regard to transportation, a table gives tanker distances between shipping and consuming centres. Tanker distances, production, and transportation costs determine the over-all international movement of oil. For example, the Suez Canal toll of 18 c/brl causes most of the European markets to be supplied from the Western Hemisphere, but the proposed construction of the new pipe-line connecting the Persian Gulf with the Eastern Mediterranean in conjunction with the shortened distance from Haifa to London would reverse the situation.

Trends indicate that the Middle East will absorb more and more of the Eastern

Hemisphere markets to the exclusion of the West, but the nature of the crude will still ensure that lubricating oils are produced in the States.

Canada should be able to take a considerable portion of the United States excess production over domestic use. Thought should be given to the possibilities of expansion of oil consumption in Asia and Africa, where more than 50% of the world's population live, but consume very little. G. A. C.

# BOOKS RECEIVED.

**Principles of Micropalæontology.** M. F. Glaessner. Melbourne, University Press; London, Oxford University Press; 1945. Pp. xvi + 296, 14 plates, 7 tables, 64 text figures. 45*s.* 0*d.*

The foundations of micropalæontology were laid a hundred years ago, and during the past twenty or thirty years the study of microscopic fossils has become an important branch of geology. Many micropalæontologists are now employed in the petroleum industry because of the value of micro-fossils in stratigraphic studies, and it is the application of micro-fossils in economic geology which has provided the main stimulus in the development of micropalæontology in recent years.

After a brief review of the history of microplaæontology, "Principles of Micropalæontology" continues with a general classification of the micro-fossils and a brief description of the micro-fossils other than the foraminifera. The greater part of the book is devoted to the palæontology of the foraminifera, and deals with their life-history, structure, classification, and palæo-ecology. The stratigraphic sequence of micro-faunas is briefly summarized, while further chapters deal with the collecting and study of micro-fossils, the micropalæontological correlation of sedimentary rocks, and the application of micropalæontology in oilfield exploration and exploitation in the Eastern Hemisphere. An appendix provides a synopsis of a revised classification of the foraminifera, and gives the stratigraphic ranges of important genera. In this connection it is interesting to note that Glaessner's doubts about the ranges of *Spirillina* and *Nodosaria*, and his indications of the dates of appearance of *Lagena*, *Dentalina*, *Cristellaria* and *Marginulina* are confirmed by Wood's recent paper on "The supposed Cambrian foraminifera from the Malverns" (Abstracts of the Proceedings of the Geological Society, London, June 5, 1946, pp. 66–67).

In oilfield and other geological work the maximum benefit is not being derived from the application of palæontology if its use is limited to correlation. Ecological studies by indicating the nature of the environment under which the fossilized creatures lived provide information on the conditions under which the sediments were formed. The inclusion of a chapter on ecology is therefore a good feature.

Tables summarize the distinctive characteristics of the super-families of the foraminifera and of the important genera of the *Astrorhizidea*, *Verneuilinidæ*, *Fusulinidæ*, *multilocular Lagenidæ* and *Buliminidæ*. The illustrations, while numerous, are not so profuse as in the illustrated key to the genera of the foraminifera, included in Cushman's "Foraminifera" (3rd Edition), a book which Glaessner includes in his list of reference books for equipping a laboratory and office for micropalæontological work. There are nearly nine hundred items in the bibliography and these are grouped according to the chapter headings.

Altogether "Principles of Micropalæontology" is well-conceived and well-presented. Consequently it is a useful addition to the textbooks on micropalæontology and worthy of the attention of those studying and applying this important subject. G. D. H.

## Technical Missions to Germany.

The following reports have been received in addition to those listed on pp. 226A to 230A.

### B.I.O.S. REPORTS.

39.* Concealed Oil Targets in the Brilon–Bredelar Area. 3 pp.
40.* Optical Activities at Steinheil u. Shöne, München. 8 pp.
202. Bergius Wood Sugar Plants at Mannheim-Rheinau and Regensburg. 13 pp.
239. Textile Auxiliary Products Manufactured by I.G. Farbenindustrie, Hainkur Works. 12 pp.
243. I.G. Hoechst—Inorganic Division. Manufacture of Sulphuric Acid, Sulphite Products and Chlorsulphonic Acid. 27 pp.

256. Phosphoric Acid and Sodium Phosphates in Germany. 27 pp.
259. Textile Auxiliary Products of I.G. Farbenindustrie, Leverkusen. 17 pp.
260. I.G. Farbenindustrie—Ludwigshafen. Manufacture of Sulphuric Acid, Sulphide Products, Liquid Sulphur Dioxide and Cyanides. 33 pp.
343. German Diesel Engine Industry. 301 pp.
353. Preparation of 5-Dimethylaminopentanol-2 by the Reppe Process. 4 pp.
356. Characterization of Butadiene Catalyst by X-Ray and Chemical Analysis. 6 pp.
359. Products Formed by Interaction of Acetylene and Amines. 3 pp.
366. German Textile Dyeing, Drying and Finishing Engineers. 13 pp.
374. German Aluminium Foil Industry. 21 pp.
392. Welding of Aluminium and Aluminium Alloys, with special reference to the manufacture of pressure vessels. 31 pp.
395. German Fluorescent Lamp Industry and Phosphor Chemical Manufacture. 96 pp.
404. German Asbestos Industry. 63 pp.
419. I.G. Waxes: Manufacture at Gersthofen and Oppau. 11 pp.
422. I.G. Ludwigshafen. Sodium Hydrosulphite and Related Compounds. 19 pp.
423. Deutsche Gold und Silber Scheide Anstalt (DEGUSSA)—Frankfurt. 50 pp.
424. Chemische Fabrik. Dr. Jacob—Bad Kreuznach. Manufacture of Carbon-bisulphide, Thiourea and Ammonuim Thiocyanate. 21 pp.
426. German Organic Chemical Industry. 4 pp.
428. German Rayon and Staple Fibre Industry and Allied Engineering Industry. 83 pp.
433. Investigation of German Plastics Plants. Part IV—Additional Information on Thermosetting Resins and Processing of Polystyrene. 90 pp.
436. Enzyme Products and "Acrisin" Finishing agents for Textiles, Röhm und Haas G.m.b.H., Darmstadt. 20 pp.
438. German Collapsible Tube and Extrusion Industries. 24 pp.
445. Investigation of German Plastics Plants. Part III—Processing of Polyvinyl Chloride. 114 pp.
450. Gesellschaft für Teerverwertung m.b.H., Duisberg-Meiderich and Castrop-Rauxel. 55 pp.
451. Titanium Pigments, Titangesellschaft, Leverkusen. 17 pp.
452. Textile Machinery. 32 pp.
455. Loom Making in Germany and Textile Machinery Accessories. 18 pp.
458. The Ceramic Industry of Germany. 51 pp.
462. Impact Extrusion. 3 pp.
468. The Manufacture of Synthetic Crystals in the Plant of I.G. Farbenindustrie, Oppau–Ludwigshafen. 5 pp.
478. Textile Auxiliary Products: Development of Mersol and Hostapon Processes by I.G. Farbenindustrie, Höchst. 47 pp.
485. German Filtration Industrie. 42 pp.
489. Chemische Fabrik Joh. A. Benckiser G.m.b.H., Ladenburg Works. Manufacture of clacium citrate. 17 pp.
507.* Dr. F. Raschig, G.m.b.H. Chemische Fabrik, Ludwigshafen. Coal Tar Distillation; Chlorinated Phenols; Phenol–Formaldehyde Resins; Synthetic Phenols. 24 pp.
510.* Samples of Petroleum Products collected from the Hamburg, Hannover, Bremen and Kiel Area. 38 pp.
511.* Ruhr-Chemie A.G., Sterkrade Holten. Interrogation of Dr. O. Roelen. 25 pp.
512.* Schlafhorst Chemische Werke G.m.b.H., Hamburg. Lubricants. 15 pp.
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# Oilfield Exploration and Exploitation.

## Geology.

**1011. Fault-wedge Reservoirs.** O. Wilhelm. *Oil Gas J.*, 20.4.46, **44** (50), 163.—Intersecting faults may give oil-traps—fault-wedge reservoirs. A fault may also be associated with some other trapping feature, such as a change in thickness or permeability, or a pinch-out, again giving trapping. These are double-trap reservoirs. Triple-fault traps are possible. G. D. H.

**1012. Explanation of Pinch-out and Erosional Unconformity.** O. Wilhelm. *Oil Gas J.*, 30.3.46, **44** (47), 275.—Wedges may be formed by natural thinning or by erosion. The former wedging depends on the relative rates of deposition and uplift or depression. It is very difficult to determine whether erosion has played any part in this type of wedging.

The presence of traps in pinch-outs and erosional unconformities depends on the relative positions of permeable and impermeable beds. G. D. H.

**1013. Wyoming Tests in Limelight.** Anon. *Oil Gas J.*, 30.3.46, **44** (47), 287.—A test on the River Dome structure in Washakie County, Wyoming, has been drilled to about 11,000 ft. Nothing worth while was found in the Tensleep, and possibly in the Amsden, but, in testing, the Embar lime at 9990–10,020 ft gave 5,000,000 cu. ft of sour gas. A second test at 9990–10,055 ft showed gas and a substantial amount of 41·5° oil. In the Frontier sands at 7229–7272 ft there were signs earlier that a good gas-condensate well could be completed, while a test of the Muddy sand at about 8150 ft is reported to have shown 200 brl/day.

The second well tested the Frontier at 7534–7554 ft, indicating 300 brl/day of condensate. The Muddy is to be tested in this well, which is about 200 ft lower structurally than the first.

Previous wells in the Palæozoic of this part of Wyoming have carried low-gravity, black, highly sulphurous oil, worth less than $1/brl. G. D. H.

**1014. New Strike Spurs Inner-basin Play.** Anon. *Oil Gas J.*, 20.4.46, **44** (50), 179.—A well (Mountain Fuel Supply Co. 1 Unit) in Uinta County, Wyoming, 30 ml north of the Utah boundary, has topped the Dakota at 12,554 ft, and had a gas-show. Through perforations at 12,660–12,666 ft a 24-hr drillstem test gave 12,300,000 cu. ft. of gas/day and 150 brl/day of 46·5-gravity oil or condensate. The bottom-hole flowing pressure was 4900 lb/sq. in.

The well is in the Bridger division of the Green River basin. It lies midway between Green River town and the Spring Valley pool, which was opened in 1900 and has produced about 200,000 brl of oil. The deepest formation which it tested was probably the Bear River (Upper Cretaceous). The La Barge field is 70 ml north of the test; its production has come mainly from the Wasatch (Eocene). G. D. H.

**1015. Present Work of the Pennsylvania Geological Survey in the Oil Fields of Pennsylvania.** C. R. Fettke. *Producers' Monthly*, May 1946, **10** (7), 23.—After a preliminary discussion emphasizing the need for geological knowledge in the exploration and recovery of oil, the work of the Pennsylvania Geological Survey in mapping and studying the oilfields of Pennsylvania is reviewed. The method of study is then briefly discussed, and the paper concludes with brief biographies of members of the staff. R. B. S.

**1016. Chilean Oil Developments.** Anon. *Oil Wkly*, 1.4.46, **121** (5), 42 (International Section).—Swan Lake, 50 ml southeast of the productive Spring Hill structure, is believed to have better prospects than the latter. Spring Hill 2 has reached 3050 ft.

The Mina Rica structure on the mainland (Brunswick Peninsula) is not deemed the most favourable of the group of structures, but it is the most accessible. A well on it was abandoned dry at 1880 ft after having had slight showings. A test, Picket 1, 9 ml north of the Mina Rica structure, is nearing 2500 ft. G. D. H.

**1017. Atlantic Deepening Well on its Haiti Concession.** Anon. *Oil Wkly*, 11.3 46, **121** (2), 78.—Jurinat 1 was originally abandoned in August 1944 at 7005 ft in the Lower Oligocene. Drilling has now been restarted, and the well has passed 7300 ft. The well lies 50 ml northeast of Fort-au-Prince. G. D. H.

**1018. Resumption of Drilling in Philippines Soon.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—Before the war encouraging oil indications were found in northern Cebu in a well taken to 8330 ft. Drilling in the Philippines may soon be restarted. G. D. H.

**1019. Anglo-Egyptian Brings in Wildcat Test Near Suez.** Anon. *Oil Gas J.*, 20.4.46, **44** (50), 91.—On the east coast of the Sinai peninsula, 40 ml south of Suez, Anglo-Egyptian Oilfields, Ltd., has had a good show of oil in a wildcat at a depth of 2700 ft. G. D. H.

**1020. Joya Mair Tests Await Construction of Storage.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—Two wells at Joya Mair have each indicated a production of 9000 brl/day of heavy oil in short tests. G. D. H.

## Geophysics and Geochemical Prospecting.

**1021. Geotechniques of Oil Exploration.** J. W. Merritt. *Oil Wkly*, 1.4.46, **121** (5), 17.—The increased difficulty of finding oil accumulations by the application of the anticlinal theory and allied concepts led to the search for some direct method of finding oil. Too much has been expected of these direct methods. The aim has been to develop a simple instrument giving direct data, but so far the methods call for interpretation of the data.

The application of the anticlinal theory is an indirect means of oil discovery, and has limitations. Soon the surface anticlines were worked, and buried structures had to be tackled via sub-surface studies and later by the seismograph or the gravity-meter. The magnetometer has also been used for this purpose.

For a direct method of oil discovery to be practicable the oil or gas must make its presence felt by detectable changes, chemical or physical, in the rocks or soil above it; these changes must give patterns the significance of which can be divined. Electrical methods have been applied, it being assumed that the oil or gas caused measurable resistivity changes. It is somewhat doubtful whether there is adequate penetration to make this method widely usable. Geochemistry has been applied in the direct search for oil and gas, particularly in the form of soil analysis. The early shortcomings were associated with a failure fully to appreciate the significance of geological factors in interpreting the data. The analyses may be for hydrocarbons, gaseous, liquid or solid, by a variety of techniques; or they may be for inorganic substances concentrated by reason of the passage of hydrocarbons to the surface. The soil may be sampled, or the gases collected from it; the sample may be from the surface or down to a depth of as much as 20 ft. The sampling points may vary widely in spacing. All these geochemical techniques are based on the belief that oil and gas escape to the earth's surface. Recently it has been observed that maps of the intensity of radio-activity over oil and gas areas closely resemble those obtained in measurements of the amounts of the critical organic and inorganic compounds. Bacteriological studies also have been employed.

The formations overlying oil and gas deposits are permeable, and certain hydrocarbons escape upward through them. The movement is vertical, disregarding dip and permeability variations. The movement is best described in terms of molecules rather than by bulk flow, and the light hydrocarbons transport with them water

vapour. These hydrocarbons may be polymerized by radioactive substances. If the passage of the hydrocarbons carries off water from the overlying rocks, solutions will enter this zone from the sides, and so solutes will be deposited, thus increasing the rock density among other features. This change alters the electrical conductivity, and the speed of passage of seismic waves; it also concentrates radioactive substances, and favours the growth of hydrocarbon-loving bacteria. False "highs" have been noted on the margins of low-dip oil- and gas-bearing domes, due to the increased velocity over compensating for increased depth.

Confirmation of pattern rather than the confirmation of data for single sites should be considered as significant. Climatic conditions may cause variation. G. D. H.

**1022. Gravimeters.** G. S. Heulin. *Form. y Doc. Prof.* (*Madrid*), 1946, **5** (12), 17–21.—A description of the use of gravimeters in detecting changes in subterranean structures. Two gravimeters are described in detail, the principle being the measurement of the very small change in position of a spring-loaded mass under different gravitational pulls. In the first the movement is measured by the change in current due to the distance changing between two plates, and in the second the moving mass cuts off part of the light from a photoelectric cell. The sensitivity of one type of gravimeter is given as 0·64 millidynes. A. C.

## Drilling.

**1023. Subsoil Problems of the Geologist During Drilling.** R. L. Milner. *Ecuad. Pet.*, 1946, **1** (3), 12–15.—The duties of the geologist during drilling are reviewed and some typical problems arising during exploration in Ecuador examined. A. C.

**1024. Problems Met in Drilling Abnormal Pressure Formations.** G. E. Cannon and R. S. Sullins. *Oil Wkly*, 27.5.46, **121** (13), 33–35. *Paper presented before American Petroleum Institute.*—Data are presented showing the estimated formation pressure in more than 100 wells in Texas and Louisiana where abnormally high formation pressures were encountered. The most important problems in connection with drilling abnormal pressures are lost returns and planning the most economical mud programme. Several possible methods of preventing lost returns are discussed. The method showing the most promise is the use of cement in zones of local weakness. The most important mud treating problems are viscosity control and conservation of weighting material. A centrifugal concentrator can be used not only to conserve weighting material, but also as an aid in controlling viscosity by removing undesirable concentrations of clay fractions from the mud system. Data are presented showing the comparative pump horsepower requirements for an average light mud—*i.e.*, 10·3 lb/gal—and a heavy mud weighing 16·3 lb/gal. The comparative carrying capacity of l light and heavy muds is also discussed, the heavy mud having considerably more carrying capacity than the light mud. This to some extent offsets the slower circulating rates which are usually obtained with heavy muds. A. H. N.

**1025. Modern Deep Well Drilling Rigs Dieselized.** M. D. Pugh. *Diesel Power and Diesel Transportation*, May 1946, **24** (5), 584.—Because of greater flexibility and economy and ease of handling, the diesel or gas engine is rapidly replacing steam power for all oil-drilling operations. Diesel- or gas-engined rigs are capable of drilling to depths of 16,000 ft and such units made by the National Supply Co. are designed to supply 1125 h.p. at the input shaft of the draw-works or hoist. Fitted with three or four engines which are connected by chain drive, they can be compounded or used separately for all drilling operations.

These multi-engines rigs, their construction, and method of operation are described, and the advantages and scope outlined. C. D. B.

**1026. Oil-Well Drilling Rigs Produced in Great Britain.** Anon. *Oil Engine*, June 1946, **14** (158), 52.—A British engineering development of recent origin is the production of equipment for drilling of oil wells. High-speed oil engines are extensively used, and the majority of the complete outfits are for overseas countries, although some are for use in the home market for exploratory work.

The article deals particularly with those produced by the Oil Well Engineering Co.,

Ltd., of Cheadle Heath, Stockport, and which have been supplied to or are on order for the major oil companies.

Typical outfits are described for drilling down to 5000 ft using 4½-inch drill-pipe with a maximum input of 425 B.H.P. from two 200-B.H.P. engines running compound with 10% overload. Precision chain drive is used running in oil-baths. The transmission unit, having three forward speeds and one reverse, affords six speeds on the drum and three for rotary drives. Scoop-controlled Fluidrive units are used on the engines with three friction clutches for the draw-works and a dog clutch for the drum, the brakes of which are water-cooled. Most of the sets have sand-reels. Without engines the draw-works weigh about 10¼ tons.

The specification is modified to suit customers' requirements, but most include a slush-pump having a maximum fluid pressure of 200 lb/sq. in.

The transmission arrangements are usually such that the two engines simultaneously can drive both draw-works and pump, or compounded on the draw-works drive. In the event of breakdown of either engine the remaining engine can fulfil either power duty.

One or other of two makes of power unit are fitted—*i.e.*, Paxman or English Electric. These units and details of installation with auxiliaries and control gear are described.

Reference is made to the latest development of rigs for drilling down to 10,000 ft, in which Paxman 12-cyl engines are employed, now under construction at Colchester.

C. D. B.

**1027. Modern Mechanical Rig Simplifies Drilling.** G. B. Nicholson. *Oil Wkly*, 1.7.46, **122** (5), 17.—The rig described is being tested on its first wildcat territory, and is operated satisfactorily on butane gas as fuel. Among the features of the rig are the simplified controls located in a protected panel immediately behind the driller's position, and the unitization of equipment to facilitate rigging up and tearing down when changing locations. The instrument panel contains numerous hand levers, which are manipulated by slight pressure of the fingers, some of which operate air-valves for controlling all clutches, including engine compounding, pump and hydromatic brake clutches. Also located in the panel are engine throttle levers and dials and guages indicating air pressures, transmission shaft speed, engine vacuum, and oil pressure. Unitization of components is practised extensively in the design of the rig. Different parts are described.

A. H. N.

**1028. Combination Drive Adapted to Unitized Drilling Power Plant.** N. Williams. *Oil Gas J.*, 29.6.46, **45** (8), 83.—The power plant described is contained in three skid-mounted units complete with individual housing forming a single large engine-house when the units are set up on a drilling location. Special features include "steam cooling" for engine jack-water. This system was designed to permit operation of the engines with high jacket water temperature (212–215° F), and consequent maintenance of a more even temperature of the engines. Temperature differentials are reduced over the length of the liners and block over the full load range from idling to full-load speeds. The high temperature, which is above the dew point of the exhaust gases, vaporizes any moisture that might be contained in the fuel or oil, so that it goes out of the exhaust, instead of condensing and being deposited on the cylinder walls, to be wiped down by the rings and mix with the oil to form sludge. Details of circulating the steam are given.

A. H. N.

**1029. "Packaged Power" Features New Rig Design.** K. B. Barnes. *Oil Gas J.*, 27.7.46, **45** (12), 207.—A portable mast rig designed for drilling down to 10,000 ft and the power unit are described in some detail. The rig is powered by 4 193-hp Waukesha engines, each of which is equipped with an air compressor to maintain air for the brakes and clutches. Each engine is coupled to the chain box-type compound by a Fawick air-clutch. Lubrication of the compound is obtained by the chains lifting oil from a bath and distributing it through pipes to a gravity feed system. One of the engines is ordinarily used to run the rotary, while the other three run the draw-works and pumping unit, but all can be used for maximum power in pulling casing or drill-pipe. The engines are synchronized by vacuum throttle control. The engines can be run on butane or on natural gas, the latter being used at the 1 Cush location. Two air-operated Foster friction catheads are incorporated in the

assembly, mounted on the transmission output shaft, and give four speeds. Draw-works have eight lifting speeds. A. H. N.

**1030. Deep Rotary Drilling Applied to the Appalachians.** B. R. Miller. *Oil Gas J.*, 6.7.46, **45** (9), 90. *Paper presented before A.P.I.*—The use of rotary system in Appalachian fields is increasing. Adaptation of rotary equipment to drilling in this section must take into account properly conditioned mud, rigs adequately powered, completion practices, drill-pipe wear, rock-bit footage, and well control. Day-work contracts have placed contractors under restraints and partly removed the incentive to improve performance. These factors with high freight charges for moving rigs, repairs, and supplies great distances, have made rotary drilling costs high. However, rotary drilling has provided such desirable benefits as: (1) Conservation of reservoir pressures; (2) Complete control while drilling and completing; (3) Selective and multiple completions; (4) Saving in casing; (5) Hole size maintained to objective; (6) Reduced drilling time; (7) They eliminate hazards of blowouts and fires; (8) They provide data for reservoir study. Principles to be observed in selecting rigs, drill pipe, bits, etc., are indicated. Mud qualities necessary in these fields are discussed. A. H. N.

**1031. Compounding Unit and Transmission Feature New Power Rig.** *Oil Wkly*, 17.6.46, **122** (3), 34–37.—Two new, large power rigs which have several new features are described. By unitizing the power-compounding assembly and making it a separate part of the rig, it was possible to design a unit which would insure proper alignment of power drives, provide wide range of operation, and permit rigid placement of specially constructed, air-operated disc clutches. Through this arrangement, one or all three of the 335-h.p. engines of the unit may be compounded in driving either the draw-works or the mud-pumps, or both. The rig is equipped with two power-driven $7\frac{1}{4} \times 12$-inch triplex slush-pumps, either of which may be operated separately or the two simultaneously. Such a feature is of particular importance to the driller where flexibility of power is required. As the depth increases, the driller may compound all the gasoline engines on the pumps, and, through the transmission, adjust the rotary speed to the desired revolution/min. The changeover from one engine to two or three, or change in operating speeds of either the pumps or the rotary table, is easy and simple by means of air-operated controls located at the driller's position. A characteristic of the new rigs is that nine forward and nine reverse speeds can be applied at the rotary table or the line drum. Several photographs illustrate the rig. A. H. N.

**1032. Oil Separator Raft Applicable to Marine Drilling.** J. E. Kastrop. *Oil Wkly*, 10.6.46, **122** (2), 33.—The separator barge has an open bottom. Thus on receiving contaminated oil the oil rises to the top and the water mixes with the marine or fresh water in which the barge is floating, and is automatically discharged. The uses of such barges are discussed. A. H. N.

**1033. A Study of Flow of Plastics Through Pipes.** R. C. Binder and J. E. Busher. *J. Appl. Mech.*, June 1946, **13** (2), A101–A105.—The pipe friction coefficient for true fluids is usually expressed as a function of Reynolds number. This method of organizing data has been extended to tests in the flow of different suspensions which behaved as ideal plastics in the laminar-flow range and as true fluids in the turbulent-flow range. In the laminar-flow range, Reynolds number below about 2100, the denominator in Reynolds number is taken as the apparent viscosity. The apparent viscosity can be determined from the yield value and the coefficient of rigidity. In the turbulent-flow range the denominator in Reynolds number is an equivalent or turbulent viscosity equal to the dynamic viscosity of a true fluid having the same friction coefficient, velocity, diameter, and density as that of the plastic. The various experimental data on plastics correlate well with this extension of the method for true fluids. A. H. N.

**1034. Plastic Cementing In Permian Basin Gas-Oil Ratio Remedial Work.** F. R. Holland. *Oil Wkly*, 17.6.46, **122** (3), 40.—The resinous cement used in this work is

a synthetic phenol-formaldehyde compound which, on hardening, forms a plastic similar in many respects to that used in the manufacture of household appliances and everyday articles such as fountain pens, phonograph records, telephones, etc. This material has properties which make it peculiarly suited for well remedial work. When it is in a liquid state it has a very low viscosity as compared to cement slurries. Its viscosity ranges from 1·5 to 4·0 poises. It has specific gravities ranging from 1·2 to 1·5. It is homogeneous material which is not contaminated by coming into contact with brines or muds. None of its ingredients will filter out when pumped through the finest screens, so there is no danger of building up a filter cake on the well-bore when the material is used. The pH of the material is 7·4.

The material hardens in 2 hours through a chemical reaction set up by mixing the materials. No catalysts are used and no heat is generated in the hardening process which might set up porosity in the finished plastic. The temperatures at which this material is hardened range from 80° F to 140° F, which are bottom-hole temperatures encountered in the Permian Basin at depths ranging from 2500 to 10,000 ft. The material hardens with time, increasing in compressive strength for several days. Experience with this material in the field is described. A. H. N.

**1035. Casing-Cementing Practices Improved In Illinois–Indiana–Kentucky Completions.** J. L. Rogers. *Oil Gas J.*, 13.7.46, **45** (10), 98.—Practical engineering problems encountered in cementing different wells are discussed. A programme of operation is described in detail, including conditioning of mud to 15 c.c. A.P.I. water loss and 36–40 sec viscosity. The success frequency of the methods used was about 97% for 200 multiple-sand completions. A. H. N.

**1036. Mathematics of Cementing and Other Problems.** Part I. R. E. Edwards. *Oil Wkly*, 27.5.46, **121** (13), 38–40.—In this part elementary calculations of areas and volumes of simple shapes are given. A. H. N.

**1037. Mathematics of Cementing and Other Problems.** Part 2. R. E. Edwards. *Oil Wkly*, 3.6.46, **122** (1), 33–35.—Simple problems in hydrostatics and hydrodynamics are treated in elementary manner. A. H. N.

**1038. Mathematics of Cementing.** Part 3. R. E. Edwards. *Oil Wkly*, 10.6.46, **122** (2), 42.—The elements of problems involving the balancing of liquid columns against each other are given. A. H. N.

**1039. Mathematics of Cementing.** Part 4. R. E. Edwards. *Oil Wkly*, 17.6.46, **122** (3), 45.—Simple problems of flow of cement are explained. A. H. N.

**1040. Chemistry of Drilling Fluids.** H. T. Kennedy. *Oil Gas J.*, 27.7.46, **45** (12), 181.—The elements of colloidal chemistry of water-base and oil-base muds are outlined. Significance and control of water loss, viscosity, stability, etc., of muds are explained, on the basis of the colloidal structure of muds. The influence of additives like sodium acid pyrophosphate, gum ghatti, starches, calcium chloride, sodium chloride, and others on viscosity and water loss is briefly indicated and illustrated by diagrams. A. H. N.

**1041. Improved Muds Contain Carboxymethylcellulose.** H. H. Kaveler. *Oil Wkly*, 8.7.46, **122** (6), 33. *Paper presented before American Petroleum Institute.*—The requirements of a good mud are listed as: (1) Low viscosity, compatible with pumpability and carrying capacity for cuttings; (2) Stability of the suspension of the weighting material, particularly in muds weighing more than 12 lb/gal; (3) A high degree of thixotropy; (4) A thin, tough, filter cake of low permeability and of good deplastering quality; (5) Temperature stability; (6) High resistance to electrolytes; (7) Responsive to treating agents and control of properties; (8) Low electrical resistance; (9) Capacity to release larger size cuttings and release gas in the mud pit; (10) Non-destructible by chemical or bacterial action; (11) Retards swelling of "bentonitic" or "heaving" shale; (12) Low initial and low maintenance cost. Tests with muds treated with sodium derivatives of carboxymethylcellulose are then described. Field

and laboratory experience has established that alkali metal carboxymethylcellulose impart superior qualities to aqueous well-drilling mud comprising the system; water plus dispersed fine mineral solids. Improvements in all the desirable properties of such muds, more particularly in water loss, filter-cake thickness, gel-strength, viscosity, salt-water resistance, and freedom from fermentation are obtained. Cellulose is an economical material to use in drilling muds, and its use results in substantial savings in direct mud costs, as well as savings in drilling and completion costs. This is particularly true of drilling in areas underlain by salt and anhydrite sections.

A. H. N.

**1042. Some Recent Developments in Mud-analysis Logging.** B. O. Pixler. *Petrol. Tech.* (*A.I.M.M.E.*), May, 1946, **9** (3); Tech. Pub. No 2026, 1–13.—Mud-analysis logging aims at identifying the fluid content of the formations drilled by the rotary method, and allows the accurate correlation of oil and gas shows with the depth. Mud-analysis logging eliminates much coring, and is especially valuable in cases where coring is particularly hazardous or the electric log is difficult to interpret correctly. An appreciation of the factors that influence the results of mud analysis, such as rate of penetration, mud properties, coring, and the characteristics of the reservoir rock as related to the "flushing effect," permits a better understanding of the mud-analysis log.

Recent studies of the relationship of the two gas readings obtained by the gas-detector instrument have proved significant. The difference between the total combustible gas reading and the higher-molecular-weight gas reading indicates the presence of methane. With few exceptions, zones not showing an increase of methane probably can be condemned.

Altogether mud-analysis logging furnishes valuable information, which generally cannot be obtained by other methods. G. D. H.

**1043. Use of Oil-Base Mud at Elk Hills Naval Petroleum Reserve 1.** R. W. Stuart. *Oil Wkly*, 27.5.46, **121** (13), 41. *Paper presented before American Petroleum Institute.*—Two commercial oil-base muds now available were tested, and found to have similar characteristics but different controlling features. The methods for controlling these muds have been the deciding factor in their success or failure on many wells. One of these commercial oil-base muds is composed of diesel oil-blown asphalt, sodium chloride, caustic soda, sodium silicate, and tall oil as the active ingredients with crushed limestone as the weighting material. The viscosity and gel of this mud are controlled by the pH, using sodium silicate and tall oil to adjust the pH as desired. This mud forms a viscous emulsion with fresh water; for this reason, great care has to be taken to prevent water contamination. Strong salt water will not interfere with the viscosity control of the mud as much; therefore, salt is used to counteract the effect of an entrained water. The other commercial oil-base mud is composed of diesel oil, air-blown asphalt, and calcium oxide, with ground limestone added for weight. The controlling factors in this mud are obtained at the mixing plant through the use of a diesel oil, having definite characteristics and an air-blown asphalt of a specified nature with the calcium oxide added as a settling inhibitor, which also combines with any water in the mud. This mud is affected by water, but additional calcium oxide will take up any excessive volume of water which might be entrained in the mud.

The use of oil-base mud at Elk Hills shows that whilst it gives no more trouble than water-base muds, it has several additional advantages in coring, in low-permeability production horizons, and in maintaining hole size to gauge. A. H. N.

## Production.

**1044. Subsurface Temperatures and Viscosity Temperature Relationships of Crude Oils in Appalachian Region.** F. M. Tignor. *Producers' Monthly*, May 1946, **10** (7), 12.—Among the physical properties of petroleum that influence its drainage from or flow through reservoir rock, viscosity is one of the most important. The viscosity–temperature relationships reported indicate the value of both subsurface temperature and viscosity data to petroleum engineering studies. The device used to measure the subsurface temperatures, a vapour-pressure-type recording thermometer with a

bulb, is described in detail. This recorder is run into a well on a steel wire line; the reeling equipment—a complete unit equipped with a clutch, emergency brake, hand crank, hydraulic governor, and hydraulic speed control—is also described in detail. A lubricator is used for running the recorder into gas wells and oil wells having well-head pressures above atmospheric. All measurements were made while the wells were shut in.

The rate of heat transfer through liquid is greater than through gas, and consequently the response of the thermometer to changes of temperature is more rapid when the thermometer is immersed in liquid than in gas. In making observations of temperatures in wells the temperature gauge was lowered into the well to the first or upper point of measurement, where its descent was stopped for 10 minutes if the gauge was immersed in liquid, and as long as 60 minutes in static gas. The gauge was also stopped similar lengths of time for temperature recordings at each successively lower point of measurement. Subsurface temperatures were measured in several pumping wells from which the rods had been pulled so that the temperature-gauge could be run in the tubing. In some other wells the tubing had been removed for clean-out work, and the gauge was run in the casing. In no well was the gauge run in the annulus between the casing and tubing.

The results of the subsurface temperature measurements made during 1945 in thirty-nine wells in the Appalachian region are tabulated, and two depth-temperature charts are illustrated. These data show that the actual deviation of the individual points from the curves of average values of the depth–temperature relationships is such that these curves cannot be used indiscriminately for estimating subsurface temperatures even in the areas represented by these data.

The results of absolute viscosity determinations on fifteen crude oil samples from thirteen fields representing thirteen different oil-producing sands in New York, Pennsylvania, and West Virginia at three different temperatures are also tabulated and shown graphically. The viscosity measurements were made with calibrated Ostwald–Fenske pipettes.

The paper is well illustrated, and eight references are given. R. B. S.

**1045. A Neutron Method of Measuring Saturations in Laboratory Flow Experiments.** E. Brunner and E. S. Mardock. *Petrol. Tech.* (*A.I.M.M.E.*), March 1946, **9** (2); Tech. Pub. No. 1986, 1–10.—In experimental studies of the mechanism of oil production it is frequently necessary to measure the oil saturation in a porous medium containing oil, gas, and perhaps brine. The measurement may have to be made at high pressure, without interrupting flow, and on a relatively small section to eliminate end effects. Resistivity methods may be used for obtaining brine saturations; gas saturations may be obtained from the apparent compressibility of the gaseous phase, although this demands interruption of flow.

A beam of neutrons is very penetrating, and its scattering by substances containing hydrogen, such as oil, is qualitatively different from that due to other substances. The neutron source employed was a metal cylinder 6 cm long and 1·8 cm in diameter, containing 211 mg of radium (as the bromide) mixed with powdered beryllium metal.

Neutrons passing through a substance rich in hydrogen are quickly slowed down; collisions with the heavier nuclei of other atoms cause a less deceleration of the neutrons. Hence the number of slow neutrons emerging from an object irradiated by fast neutrons gives a rough index of the amount of hydrogen it contains. Boron and lithium are easily disintegrated by slow neutrons, and so the latter are readily detected in an ionization chamber lined with one of these elements or filled with boron trifluoride gas. Such a chamber must be adjusted to operate in the presence of gamma-ray ionization. Alternatively, the slow neutrons may be detected by measuring the radioactivity they induce in a suitable material. Rhodium has been proved quite suitable for this purpose, since it is not strongly activated by fast neutrons or neutrons of intermediate speed.

The steel core-holder was 2·6 inch internal diameter and with 0·5-inch walls. The unshielded side of the neutron source was towards the core-holder and at a fixed distance from it. A second lead shield was placed on the opposite side of the core-holder. The two rhodium detector plates were held between the neutron source and the core-holder. The plate is first exposed for 5 min, then quickly removed from the neutron source-holder and placed in position near the Geiger–Mueller tube, and

exactly 15 sec after removal counting is started and continued for 3 min. The timing is done automatically, since it is most important. The background count is deducted in order to obtain a measure of the activity of the plate. The second plate is exposed at the appropriate time, and the plates are used alternately, each being used at approximately half-hour intervals.

A calibration curve for interpreting the neutron data on saturations was obtained by weighing. It is preferable to plot relative activity against saturation. The positions of the neutron apparatus and the porous medium must be the same under test as in calibration. Tests with different hydrocarbons showed that some factor other than carbon/hydrogen ratio is involved. When used with a two-phase hydrocarbon system, oil and gas, a calibration curve will be needed for each pressure, since the gas density varies with pressure. For three phases, oil, gas, and brine, the saturation of one must be measured independently of the neutron method—*e.g.*, the brine saturation might be determined electrically, but the neutron apparatus must be calibrated with the three phases.

The neutron apparatus can be used to measure saturation distribution accurately, provided the gradient is not too high. G. D. H.

**1046. Meaning of Petroleum Reserve Estimates.** R. J. Gonzalez. *Oil Wkly*, 10.6.46, **122** (2), 49–50.—A comparative study of the two methods of reserve estimates, the A.P.I. and P.A.W. methods, is made. It is concluded that: (1) Properly interpreted, the A.P.I. and P.A.W. reserve estimates are consistent, although they use different methods for determining discoveries and estimated year end reserves; (2) The two methods indicate a declining trend in discoveries during the war, the average for 1941–44 being at least one-third less than 1937–40; (3) Experience for the last 8–15 years indicates that initial estimates of discovery, made at the close of the discovery year, are later revised upward by 150–200% on the average; (4) Revisions for the period 1937–44 appear to have been distributed about as follows to the sequence of prior years: 30%, 12, 10, 8, 6, 5, 4 to the seventh prior year, and 25% to all other prior years; (5) It would be better for the industry to use the rate at which reserves are being produced rather than " years' supply " as an index of the relation of reserves and production. A. H. N.

**1047. An Application of Statistical Methods to Core Analysis Data on Dolomitic Limestone.** A. C. Bulnes. *Petrol. Tech.* (*A.I.M.M.E.*), May 1946, **9** (3); Tech. Pub. No. 2025, 1–16.—Methods of statistical analysis have been applied to the study of core analysis data of dolomitic limestone from the San Andres formation at Wasson and the Clearfork formation at Fullerton. Probability relationships are shown to connect the porosity and the permeability, and the porosity and the fluid saturation. Thus, the porosity–permeability relationship expresses the probability that a sample of porosity, $f$, will or will not be permeable.

The over-all porosity frequency distribution of the reservoir, together with the frequency curves of permeability (one for each class interval of porosity), provide a precise basis for computing the weighted average productive porosity of the reservoir for any assigned value of the minimum productive permeability. The probability that the permeability of a core specimen from Fullerton will exceed a given value appears to be dependent on the percentage porosity of the specimen, its void structure type (*i.e.*, porosity in the qualitative sense), and the given value of the permeability. If continuous profiles of void structure type and porosity are available, together with the appropriate porosity-probability of permeability plots, the net pay thickness may be estimated.

The Invasion Index of a well is defined in terms of the porosity and permeability data. This index is suggested as a basis for comparing wells as regards their suitability as fluid-injection wells. G. D. H.

**1048. Exploration and Production of Petroleum. I.** Anon. *Ind. Min.* (*Argentina*), 1946, **6** (58), 85–88.—Methods of surface prospecting are classified into six groups—viz., measurement of gravity, changes in magnetism, seismographic, electrical resistance, soil analysis, and analysis of hydrocarbons in the soil. The details and applications of these methods are considered. A. C.

**1049. Exploration and Production of Petroleum. II.** Anon. *Ind. Min.* (*Argentina*), 1946, **6** (59), 41–44.—A review of exploration methods used in conjunction with drilling, including electrical resistance, geochemical analysis, differences in radioactivity as detected by gamma rays, and fluoroscopic examination. The paper referred to in this and the preceding abstract is a digest of a book published by the Standard Oil Co. A. C.

**1050. Plastic to Increase Oil Well Output.** Anon. *India Rubber J.*, 1946, **111** (1), 3.—A plastic, phenolic resin has been tested in a West Texas oilfield (11,500 ft underground) to seal walls against the intrusion of natural gas, and the tests indicate that a well, the allowable output of which was as low as 1 brl per day through this cause, could be restored to normal production. The resin, introduced into the shaft as a true liquid, permeates the porous rock through which the gas has been filtering, and hardens. C. N. T.

**1051. Core Analysis Based on Vacuum Distillation.** C. M. Beeson and N. Johnston. *Petrol. Tech.* (*A.I.M.M.E.*), March 1946, **9** (2); Tech. Pub. No. 2017, 1–14.—The gravimetric–vacuum distillation method of core analysis was developed to permit rapid and accurate determinations of the oil/water ratios of small samples or sands containing little oil. The method usually cleans the samples so well and with so little alteration that rapid determinations of the porosity and permeability may be made on the evacuated cores.

The distillation tubes and traps can be constructed by simple glass-blowing from the usual glassware. Electrical heaters are used, and the traps are immersed in a mixture of kerosine and solid carbon dioxide. The procedure requires about 40 min, and consists of raising the temperature and maintaining it between 675° and 725° F for at least 10 min while the pressure is held between 1 and 2 mm of mercury. The fluids condensed in the trap are separated by centrifuging, and the volume of water is recorded. Determinations of changes of weight with an analytical balance of all parts of the apparatus permit computation of the weight of oil distilled and total weight of oil recovered.

An appendix discusses in detail calibration tests for determining the oil/water ratio. It also deals with the change in gravity of oil during vacuum distillation, the reliability of the method for finding the oil/water ratio, and the determination of permeability, porosity, and saturation. G. D. H.

**1052. Secondary Recovery Production Research.** (A Monthly Review.) R. V. Hughes. *Producers' Monthly*, May 1946, **10** (7), 9.—This month's review is restricted to a discussion of the effects of organic material in flood-water and methods for its removal: one of the chief requirements for an ideal flood-water being the absence of all organic material. Many pressure plants in the Bradford field have been equipped with chlorinators for killing all organic growth, which in turn is removed from the input waters by the filter system. Copper sulphate, sodium hypochlorite, and calcium hypochlorite have been used in the past for destroying organic growths without gaining particular favour. The majority of failures of the chlorination method are not the fault of the principles of chlorination nor of the equipment used, but are due to insufficient attention being given to the condition and chemical properties of the raw water in use, and other simultaneous water treatment at the pressure plant.

Several kinds of bacteria can cause corrosion of iron by direct oxidation or by the formation of acids or hydrogen sulphides, both of which attack iron. Not only such corrosion products, but the bacteria themselves may be carried to the sand face of the input well to cause plugging.

As it normally requires so little chloride to destroy organic growths and all operators use considerably more than the requirements, there is a general feeling that no living organism should reach the sand face of input wells. Since it is known that they do, there must be some overlooked factors. Some authorities have stated that sulphate-reducing bacteria are not destroyed by the usual chlorination process, and these attack sulphates in the water, producing hydrogen sulphide, which causes corrosion, etc., as mentioned above. Sulphate-reducing bacteria, however, are not common in raw water supplies. One is therefore led to conclude that the amount of chlorine added to the water is not a guide as to its effectiveness. The only guide is the measure of

residual chlorine at designated points in the water system. Adequate residual chlorine at the filter discharge does not insure protection beyond that point. The proper residual should exist at the sand face initially and at the suction end of the pressure pump at all times to insure adequate protection. Other factors complicate the problem : sufficient oxygen must be present to meet the organic oxidation demand before the chlorine becomes effective, but excess oxygen increases corrosion ; excess of chlorine makes the water more acid, and in many pressure plants lime or caustic soda is subsequently added to increase the pH.

In conclusion the author states that careful study of the entire water-treatment problem and co-operation on the part of the commercial laboratories and the producers can only result in better defining the ideal flood-water and how to obtain it.

R. B. S.

**1053. Effect of Oil-Soluble Wetting Agents on Water and Oil Production in Secondary Recovery.** J. N. Breston and W. E. Johnson. *Producers' Monthly*, May 1946, **10** (7), 28.—This paper is a preliminary report on some of the researches carried out by the Pennsylvania Grade Crude Oil Association on the general problem of increasing oil production by reducing the water intake of the loose sands and increasing production of the tight sand. Most of the work done to date has been concentrated on the selective plugging the input well.

Various methods of selective plugging have been proposed. Among them are: (1) the use of an aqueous dispersion of a bituminous substance which will penetrate the sand and then coagulate at the desired place ; (2) the injection of a solvent containing a dissolved plastic material. The water in the sand gradually dissolves the solvent, causing the plastic to be precipitated ; and (3) to preferentially oil-wet as much as possible of the sand contiguous to the well. It is expected that this should reduce the water permeability of the sand.

Using oil alone, it is not easy to oil-wet a sand surface which is already water-wet. To accomplish this easily it has been suggested that an oil-soluble wetting agent be incorporated in the crude which is to be employed in oil-wetting the sand. Two of such oil-soluble wetting agents were selected as representative, and were used in the experiments reported. One of these was an alkyl amine called Paramin, which is made by chlorinating and then aminating a kerosine fraction of crude oil. The other was a substituted oxazoline called Alkaterge-C, which is a high-molecular-weight amine. These compounds were used in 1% concentration in the crude oil for the sand-wetting experiment. The specific problem for investigation was to determine if and how much the water permeability of a water-wet or watered-out sand would be reduced by preferentially oil-wetting the sand with the aid of these oil-soluble wetting agents. The experiment was tried on a long diamond core (18 in.), taken from a horizontal well of the Franklin, Pennsylvania, oil mine, and on two sections of a diamond core of Bradford sand, using 1% solutions of the wetting agents.

The experimental procedure is described, and the results obtained are shown tabularly and graphically. These results indicate that instead of reducing the water permeability of the core by oil-wetting the sand with the aid of this wetting agent, the permeability was increased. Saturating with plain crude did, however, reduce the water permeability, but only for a few hours, lasting only until the crude was flooded out. Evidently, though the sand had become oil-wetted, the reduction in interfacial tension between the oil and flood-water made it easier for the water to pass through the oil-wet sand. However, the experiments also indicated that increased oil recovery in water-floods may be possible by the use of oil-soluble wetting agents. There was a decrease in residual saturation in each experimental flood following a saturation with crude plus wetting agent. Water production is increased along with oil production. Economically the increased oil production may possibly compensate for the increased water production.

The authors state that further experiments are necessary to substantiate and elaborate on these results. Six references are given. R. B. S.

**1054. Amine Type Wetting Agents as Acid Corrosion Inhibitors.** J. N. Breston. *Producers' Monthly*, May 1946, **10** (7), 19.—The purpose of a corrosion inhibitor is : (1) to protect steel equipment from corrosion and avoid leaks, and (2) to maintain a

constant pH in the flood-water—*i.e.*, to keep the acid from being spent on the iron and steel. Since acid flood-water (pH 2·5–3) had been found favourable for flooding purposes, experiments were conducted to find suitable acid corrosion inhibitors. Such an inhibitor should be water soluble, effective for days, and not plug the sand or interfere with oil recovery.

Commercial inhibited acid did not produce the desired results because (1) much of the inhibitor would precipitate out on diluting the acid, and (2) it was not effective in keeping down the pH of the water more than two or three days. However, slightly water-soluble wetting agents had previously been found to reduce corrosion considerably : also some of the amines (which are water soluble) are effectively germicidal and keep down bacterial growths.

Extensive tests were made of the Pennsylvania Grade Crude Oil Association to determine the value of such agents as acid corrosion inhibitors. These tests are described in detail, together with illustrations of apparatus and tables and graphs of the results obtained. They indicate that certain amine-type wetting agents could be used effectively to inhibit acid corrosion of iron and steel in dilute acid solutions (pH 2·5). The inhibitors are effective in concentrations as low as 5 p.p.m., and it is expected that the concentration may be reduced even further after the metal has once been wetted effectively with the inhibitor. The inhibitors tested are less effective when used to protect brass, and give only limited protection to copper. Hard water and dilute brines do not impair their effectiveness. They will not protect metal from oxygen corrosion, but will reduce iron pick-up by oxygen-free water. Since these inhibitors are effective in concentrations of but a few parts per million, and none of them is expensive, their use is economically possible.

Only one reference is given. R. B. S.

**1055. Current Concepts of Secondary Recovery.** N. van Wingen and N. Johnston. *Oil Wkly*, 1.7.46, **122** (5), 24. *Part of a paper presented before American Petroleum Institute.*—The literature is studied and the results are summarized. (These summaries cannot be further abstracted, as they are themselves condensed statements very concisely made, and should be consulted.) However, a point worth noting is that the majority of the research performed to date has dealt with unconsolidated sands, and has been conducted without the consideration of a second immiscible liquid phase to simulate interstitial water. Yet, as producing sands normally contain water, it is to be seriously questioned if results of experimental laboratory work on samples 100% oil saturated can be applied to actual field problems. Likewise, it is to be cautioned that any conclusions based on experimental work performed with one type of sand do not necessarily apply quantitatively to any other sand. Also, great care should be exercised with regard to the application of results of laboratory experiments to problems of reservoir behaviour, as a small model may not always adequately duplicate the behaviour of the prototype. Nevertheless, the literature does contain very useful and valuable results, which are summarized. A. H. N.

**1056. Fluid Power Makes Subsurface Production Data Automatically Available.** K. B. Barnes. *Oil Gas J.*, 29.6.46, **45** (8), 94.—The working of the hydraulic system of deep-well pumping is described : power oil is pumped by a triplex pump to the underground combination of engine and pump. The hydraulic engine piston actuated by the power oil drives the pump piston. The power oil is exhausted into the well. Bottom-hole pressures are evaluated from the pressure required by the power oil to lift the oil and well-depth data. The calculations required are indicated.

A. H. N.

**1057. Stripper Well Pumping Problems.** C. D. Borland. *Oil Wkly*, 1.7.46, **122** (5), 28.—A brief discussion of troubles encountered with pumping small volume wells from gas, wax, sand, old equipment, etc., is given. A. H. N.

**1058. Coagulation in Flood-water Treatment.** Anon. *Oil Wkly*, 17.6.46, **122** (3), 62.—The most widely used coagulants in various treatment processes are compounds of iron and aluminium—namely, aluminium sulphate, potassium alum or ammonia alum, sodium aluminate, aluminium chloride, ferric chloride, ferrous sulphate, chlorin-

ated copperas, and ferric sulphate. Of these compounds, alum is the most widely used for coagulation in flood-water treatment. Aluminium or iron sulphate added to raw, untreated water for coagulation acts in three general ways: (1) formation as aluminium hydrate or ferric hydrate, which is the gelatinous flocculent precipitate referred to as the "floc"; (2) formation of a positive trivalent Al or Fe ion, which is effective in precipitating negative colloids; and (3) formation of a negative divalent ion ($SO_4$), which is effective in precipitating positive colloids. In these actions, as is true of the entire coagulation process, it is very essential to have good floc formation, not only to permit proper action of the floc, but also a rapidly settling heavy floc, which may nearly all be removed by settling prior to filtration. This allows maximum length filtration runs between filter back-washings. Control of pH of water is an essential factor. A. H. N.

**1059. Some Factors Influencing the Plugging Characteristics of an Oil-well Injection Water.** W. F. Cerini, W. R. Battles, and P. H. Jones. *Petrol. Tech.* (*A.I.M.M.E.*), May 1946, **9** (3); Tech. Pub. No. 2028, 1–12.—A test for determining the plugging characteristics of an oil-well injection water has been developed. It consists in measuring changes of the filter-rate of a water at constant pressure with cumulative throughput when passing the water through a medium-grade sintered glass disc. This test has been applied to evaluating the plugging characteristics of the treated injection water used in an experimental water-flood in the Richfield district. The tests show that the finished water from the treating plant rapidly developed increasing plugging tendencies on ageing, even though the initial quality of the water from the plant filter as determined from the evaluation test was good. The plugging material formed upon ageing the water was approximately 40% inorganic and 60% organic, the former consisting of 90% calcium carbonate and 10% ferric hydroxide. The presence of live bacteria alone did not appear to cause appreciable plugging. At a pH of 6·4 or lower the growth of bacteria was inhibited. Lowering of the pH of the treated plant water from 7·5 to 6·4 by injection of carbon dioxide reduced the formation of plugging material with ageing. Treatment with chlorine, hydrochloric acid, or a combination of carbon dioxide and chlorine materially increased the formation of plugging materials with ageing.

No entirely satisfactory explanation can be offered to cover the occurrence of the plugging materials and the effects of the various treatments, the data indicate rather conclusively that none of the treatments would in themselves produce a water which would not cause plugging after ageing. They also show that a simple filtration after ageing would produce a relatively stable non-plugging water of better quality than could be produced by chemical treatment, ageing, and filtration. Storage, and ageing, cannot be avoided, and hence that installation of a filter in the input-well supply line would appear to be the best means of preventing plugging. G. D. H.

**1060. Laboratory Investigations of Chemical Changes on East Texas Oilfield Water Affecting its Injection into Subsurface Sands.** F. B. Plummer and I. W. Walling. *Petrol. Tech.* (*A.I.M.M.E.*), March 1946, **9** (2); Tech. Pub. No. 2019, 1–14.—The presence of sulphate-reducing bacteria in oil-wells producing salt water has been demonstrated. At 125° F bacteria alone reduce the sulphate content of East Texas brines by only 3% in 30 days, with the formation of hydrogen sulphide, and sodium or calcium hydrogen sulphide, and sodium or calcium hydroxide chiefly. The hydrogen sulphide reacts with soluble iron compounds to produce iron sulphide in the absence of oxygen, and ferric hydroxide where oxygen or air is present. These compounds, if formed or carried into a well, lead to clogging of the sand. A reduction of the amount of sludge due to iron compounds may be attained by reducing the sources of iron, by using concrete or lined iron tanks, and coating pumps, pipelines, etc., with non-metallic material.

Where iron or other metals and iron sulphide are already in the water containing bacteria, 100% reduction of the sulphates is complete in 30 days or less; where magnesium is present, reduction is complete in 15 days. Little reduction took place at 60° or 70° F, and maximum reduction and most formation of hydrogen sulphide occurred at 125° F, with no reduction at 150° F. The greater the amount of ferrous sulphide sludge, the greater the sulphate reduction.

Phenol, formaldehyde, creosote, thiokol, and other bactericides killed the bacteria in the brine and prevented sulphate reduction and hydrogen sulphide formation. The bactericides should be applied to the stagnant spots of the fluid-circulating systems. Streamlining by eliminating stagnant spots is beneficial, since the sulphate-reducing bacteria are strictly anaerobic. Oxidized ferrous sulphide sludge (ferric hydroxide sludge) prevented sulphate reduction.

The addition of bactericides, and frequent aeration or oxidation of the substances which favour bacterial growth, may provide a solution of the hydrogen sulphide problem of fields like East Texas. G. D. H.

**1061. Efficiency of Water Drive in Illinois Sand Reservoirs.** A. W. Baucum and W. D. Steinle. *Oil Gas J.*, 27.7.46, **45** (12), 199. *Paper presented before A.P.I.*—The geological structural features of the reservoirs and the properties of both formation media and reservoir fluids are described and quantitatively tabulated where possible. Production data and well-spacing are then discussed and results of the recovery briefly analysed. A. H. N.

**1062. Mid-Continent's Shallowest Water-drive Project Affords Interesting Study of Contrast to Deeper, Flush-type Oil Production.** R. O. Bankson. *Oil Gas J.*, 29.6.46, **45** (8), 109.—The field is comparatively small. So far, 75 acres have been drilled up and flooded, and the development of 60 additional acres planned for the near future will complete the work on the acreage owned in this area. To January 1, 1946, 217,402 brl of oil have been produced, and, of this, 68%, or 147,711 brl, were recovered from 34 acres. The water-flood recovery from the 34-acre parcel which has now been abandoned amounted to 4345 brl/acre. Operation of the remaining 41 developed acres is continuing. The wells are shallow and easy to drill; total time for drilling, shooting, cleaning out, and moving away is some 50 hours. Details of the field characteristics are given. A. H. N.

**1063. Design and Operation of Subsurface Salt Water-disposal Systems.** H. H. Elliston. *Oil Wkly*, 10.6.46, **122** (2), 34.—Cost estimates are given for injection of salt water for disposal purposes. A detailed study of the engineering of salt-water disposals shows that the most economical way is to form mutual, non-profit associations of companies—*i.e.*, to treat the problem as a large unit. Important items to be considered and a classification of the various schemes available are given in a long outline form. A. H. N.

**1064. Separator Pressure Used for Salt-water Disposal.** G. B. Nicholson. *Oil Wkly*, 27.5.46, **121** (13), 36–37.—The system described uses knock-outs converted from separators for removing all the water possible from the production, employing a closed disposal system which utilizes knock-out pressures for injecting the water into input wells. A relatively small percentage of emulsified water remains with the production after leaving the knock-outs, and only this portion is directed through the gun-barrels and heating system with the oil for treatment. Details of the system are given. Between 85% and 90% of the water is removed, and it is claimed that this fact reduced the extent of corrosion in the lines, treaters, etc., as a closed system is used. A. H. N.

**1065. Penetron Detection of Corrosion Inside Distillate Producing Equipment.** F. B. Gordon and P. H. Lipstate, Jr. *Oil Wkly*, 17.6.46, **122** (3), 38.—The use of penetrating gamma rays by means of the "penetron" to detect corrosion inside pipe lines proved successful in showing thinner pipe walls where corrosion attacks were pronounced. A. H. N.

**1066. Formation Penetrating with Shaped Explosive Charges.** R. H. McLemore. *Oil Wkly*, 8.7.46, **122** (6), 56.—The charge is an adaptation of the techniques used by the Army during the war in the "bazooka" rockets and various other demolition charges. The principle of the "shaped" charge, often called the "cavity effect of explosives," consists of leaving a cavity in the explosive at the very spot where the maximum force is desired. In packing the explosive into the charge, a cavity in the

shape of a cone is left in the forward end of the charge. Upon detonation, the explosive force is focused in this cavity, and emerges as a high-velocity stream of hot gases intermingled with fine particles of the material used in forming the cavity. In the formation penetrator this cavity is placed in the charge, so that it will be adjacent to the formation at the point at which penetration is desired. The size and shape of the cavity, the material with which it is lined, and the type of explosive used, all have an effect on the penetration which will be attained. Experiments on steel cylinder blocks as targets show that the shape charge can drill a hole right through the block which the ordinary charge left unaffected. A. H. N.

**1067. Efficient Use of Oil-well Packers.** J. M. Walker. *Oil Wkly*, 1.7.46, **122** (5), 20.—Different types of well-packers available are described. In selecting a packer the first consideration is that of the most suitable size, but after this requirement is fulfilled, several others have to be taken into account, including the method of removing the packer. Some of the considerations necessary are discussed. A. H. N.

**1068. Water Well Intake Chart.** K. B. Nowels. *Oil Wkly*, 8.7.46, **122** (6), 39.—A nomographic chart is presented for solving water well intake problems in five spot water-flood spacing pattern. A. H. N.

**1069. Drilling and Production Patents.** L. E. Beck. U.S.P. 2,400,478, 21.5.46. Power-driven earth auger.

F. A. Kent and C. W. Patrick. U.S.P. 2,400,515, 21.5.46. Method of purifying and deodorizing crude oil.

W. L. Denman, assr to Dearborn Chemical Co. U.S.P. 2,400,543, 21.5.46. Method of treating waters and composition therefor.

J. Neufeld, assr to Well Surveys. U.S.P. 2,400,593, 21.5.46. Method of and apparatus for investigation of cased drill holes.

G. Althoff. U.S.P. 2,400,622, 21.5.46. Device for the hydraulic transmission of power.

G. E. Archie, assr to Shell Development Co. U.S.P. 2,400,678, 21.5.46. Method and apparatus for electrically logging wells.

W. A. Eaton, assr to Bendix-Westinghouse Automotive Air Brake Co. U.S.P. 2,400,688, 21.5.46. Fluid pressure control system.

C. Prather and F. A. Rydberg. U.S.P. 2,400,712, 21.5.46. Drill pipe spinner.

W. B. Rhees. U.S.P. 2,400,713, 21.5.46. Process and apparatus for the demulsification of hydrocarbons.

A. McMillan, assr to Chain Belt Co. U.S.P. 2,400,765, 21.5.46. Mechanism for actuating clutches and the like.

W. P. Stilley. U.S.P. 2,400,853, 21.5.46. Well drilling apparatus.

J. H. McFarlane. U.S.P. 2,400,941, 28.5.46. Sucker rod connection.

R. C. Baker, assr to Baker Oil Tools. U.S.P. 2,400,970, 28.5.46. Lock device for well tools.

P. H. Brace, assr to Petrolite Corpn. Ltd. U.S.P. 2,400,975, 28.5.46. Apparatus for electrically resolving water-in-oil emulsions.

B. L. Evering and A. P. Lien, assrs to Standard Oil Co. U.S.P. 2,400,985, 28.5.46. Desalting crude oils.

V. Voorhees, assr to Standard Oil Co. U.S.P. 2,400,986, 28.5.46. Desalting crude oils.

S. M. Akeyson and W. L. Stockham, assrs to Nobs Chemical Co. U.S.P. 2,401,035, 28.5.46. Well screen.

H. L. Cupples, assr to The United States of America. U.S.P. 2,401,053, 28.5.46. Measurement of surface tension.

A. J. Granberg. U.S.P. 2,401,067, 28.5.46. Water separator.

O. V. Lindquist, assr to J. K. Smit & Sons. U.S.P. 2,401,087, 28.5.46. Diamond drill bit.

R. G. Taylor, jr., assr to The Guiberson Corpn. U.S.P. 2,401,119, 28.5.46. Well tool.

C. W. Kandle. U.S.P. 2,401,250, 28.5.46. Earth drill.

J. E. Walstrom, assr to Schlumberger Well Surveying Corpn. U.S.P. 2,401,280, 28.5.46. Method for locating permeable formations traversed by boreholes.

J. M. Pearson and C. R. Nichols, assrs to Sperry-Sun Well Surveying Co. U.S.P. 2,401,371, 4.6.46. Electrical prospecting method and apparatus.

F. J. Wright, assr to The Denison Engineering Co. U.S.P. 2,401,397, 4.6.46. Control valve for hydraulic systems.

F. B. Doane, assr to Magnaflux Corpn. U.S.P. 2,401,467, 4.6.46. Method of and apparatus for magnetic testing for cracks or other imperfections.

M. G. Schutte and N. L. Schutte. U.S.P. 2,401,515, 4.6.46. Underreamer.

R. C. Mason. U.S.P. 2,401,576, 4.6.46. Device for measuring length of a line run into or removed from a bore hole.

E. G. Schick, assr to Schick-Siegal Industries. U.S.P. 2,401,665, 4.6.46. Oil well choke.

W. A. Eaton, assr to Bendix-Westinghouse Automotive Air Brake Co. U.S.P. 2,401,680, 4.6.46. Fluid pressure control mechanism.

C. Heeter, assr to C. M. Heeter, Sons & Co. U.S.P. 2,401,871, 11.6.46. Vacuum sand pump for wells.

E. B. Williams, jr. U.S.P. 2,401,893, 11.6.46. Side wall core barrel.

A. Pranger, assr to The Guiberson Corpn. U.S.P. 2,401,960, 11.6.46. Pressure drilling head.

R. A. Salathiel, assr to Standard Oil Development Co. U.S.P. 2,401,966, 11.6.46. Process and agent for breaking petroleum emulsions.

A. J. Zschokke, assr to Lane-Wells Co. U.S.P. 2,402,002, 11.6.46. Contact means for electrically operated well tools.

E. R. Zeek, assr to Specialties Development Corpn. U.S.P. 2,402,196, 18.6.46. Method of and apparatus for separating fluids.

K. A. Wright, assr to B. and W. U.S.P. 2,402,223, 18.6.46. Rotary well bore cleaner.

F. C. Carpenter, assr of one-half to Eastman Oil Well Survey Co. and one-half to Eastman Oil Well Survey Corpn. U.S.P. 2,402,238, 18.6.46. Well deflecting tool.

L. C. Hufford. U.S.P. 2,402,284, 18.6.46. Pressure control.

J. M. Shimer. U.S.P. 2,402,300, 18.6.46. Fluid actuated mechanism.

E. R. Price, assr to Bendix Aviation Corpn. U.S.P. 2,402,344, 18.6.46. Fluid pressure system.

J. P. Ratigan. U.S.P. 2,402,345, 18.6.46. Apparatus for cleaning pipes and tubing.

K. C. D. Hickman, assr to Distillation Products. U.S.P. 2,402,401, 18.6.46. Apparatus and method for dehydrating in the frozen state.

S. C. Hurley, jr. U.S.P. 2,402,405, 18.6.46. Photoelectric inspection device.

J. El Munn, assr to Chemical Service Co. U.S.P. 2,402,433, 18.6.46. Treatment of oil wells.

V. E. Haury and S. A. Ballard, assrs to Shell Development Co. U.S.P. 2,402,495, 18.6.46. Capillary active salts.

D. M. Lawrence, assr to Bendix Aviation Corpn. U.S.P. 2,402,499, 18.6.46. Pressure regulating system.

R. B. S.

## Oilfield Development.

**1070. February Exploratory Drilling Increases.** Anon. *Oil Wkly*, 25.3.46, **121** (4), 43.—During February U.S. exploratory well completions averaged 78·8 per week. 21·3% of the tests were successful. 71 oil discoveries have been made in January and February, 51 being new fields; 26 new gas discoveries have been made, 24 being new fields.

Tables summarize by States and districts the exploratory drilling results for February and for the first two months of 1946, classifying the discoveries according to their types. The February discoveries are listed with pertinent data. G. D. H.

**1071. Completions Ahead of 1945 Rate.** Anon. *Oil Wkly*, 22.4.46, **121** (8), 43.—During the first three months of 1946, 6355 wells were completed in U.S.A., 12·5% more than in the first quarter of 1945. 2029 wells were completed in the four weeks ended March 30, 1945. Marked increases over the first quarter of 1945 were shown in Texas, Oklahoma, Louisiana, Illinois, Kansas, and Pennsylvania.

A table summarizes the completion results during March and during the first quarter of 1946. G. D. H.

**1072. Summary of February Completions.** Anon. *Oil Gas J.*, 30.3.46, **44** (47), 308.—During February 1940 wells were completed in U.S.A., 112 finding oil and 213 obtaining gas. G. D. H.

**1073. Alberta in 1945.** C. O. Nickle. *Oil Wkly*, 1.4.46, **121** (5), 24 (International Section).—During 1945 minor oil-pools were opened at Hay Lake and South Princess, the Conrad pool was expanded, and large extensions were made to the Medicine Hat, Princess, and Viking-Kinsella gas reserves.

124 wells were completed in 1945, 17 being at Turner Valley. 57 wells were dry; 46 obtained oil and 16 gas.

Conrad produces from the Ellis at about 3000 ft. The trap is a pinchout. 14 producers and 13 dry holes have been drilled within a 6-ml radius. The producing area is about 2½ ml long and up to 1 ml wide.

Empire-Pacific 1, 6 ml south of the Devonian oil-wells at Princess, was completed as a Chert zone discovery at 3323 ft, giving 45 brl/day of 28-gravity oil by pumping. The Chert is the erosional surface of the Madison limestone. Empire-Pacific 2, ¼ ml to the south, flowed 60 brl of 28-gravity oil with 6000 Mcf of gas/day from the Madison limestone at 3315 ft. This well found the Devonian dolomite water-bearing.

3 ml southeast of the Princess Devonian wells a Sunburst (Lower Cretaceous) sand discovery was made at 3184 ft. The well gave 45 brl/day of 28-gravity crude with very little gas. Two large Sunburst gas-wells, with some oil, were completed several miles south and southwest of this well.

The Devonian dolomite pool at Princess is a narrow strip, 1¼ ml long. The Princess area may have gas reserves of 300,000 million cu. ft.

The Hay Lake dome is 4 ml north of the Montana border. Madison limestone production has been found at 3094 ft. The Medicine Hat pool now covers 58,000 acres, and has gas reserves estimated at 170,000–400,000 million cu. ft. Production is obtained from the Upper Cretaceous at 925–1225 ft. The Viking-Kinsella gas-pool covers 50 sq. ml., and has reserves of 200,000 million cu. ft. The pool may ultimately cover 400 sq. ml, and may have reserves of 600,000 million cu. ft. This field produces from the Upper Cretaceous Viking sand at 1940–2375 ft.

The Brazeau anticline is viewed favourably. Madison limestone was found at 9498 ft, but was underlain by younger beds at 9597 ft. The Madison was re-entered at 11,351 ft and the Blairmore at 11,599 ft. A small gas-flow was met in the tight lower limestone. The upper limestone is also tight, but has given more gas and a show of crude. After acidization the well gave 2,500,000 cu. ft. of gas/day with some light oil. Further acid treatment quadrupled the gas flow. G. D. H.

**1074. Decline Noted in Year's Production in Ecuador.** Anon. *Oil Wkly*, 1.4.46, **121** (5), 50 (International Section).—During 1945 Ecuador produced 2,622,724 brl of oil. The 1944 figure was 2,892,188 brl. 2,475,113,000 cu. ft. of gas was treated in 1945 to recover 41,768 brl of gasoline. G. D. H.

**1075. Argentine's 1945 Output Shows 5·6% Drop.** Anon. *Oil Gas J.*, 20.4.46, **44** (50), 91.—In 1945 22,880,000 brl of crude was produced in Argentina. Private production amounted to 7,426,143 brl. Natural-gas production in 1945 was 21,495,915,000 cu. ft, 8·1% less than in 1944. G. D. H.

**1076. Discovery of Petroleum in Chile.** A. D. Bolland. *Bull. S. Amer. Inst. Pet.* 1946, **2**, 311–312.—Springhill No. 1 (Tierra del Fuego) came into production on December 29, 1945. The crude has a gravity of 39·7° A.P.I., and is suitable for the production of lubricating oils. A. C.

**1077. South American Petroleum Reserves.** V. Oppenheim. *Bull. S. Amer. Inst. Pet.*, 1946, **2**, 267–271.—Production in 1944 was 338 million brl (about 13% of total world production). Known reserves are about 30,000 million brl, but a much fuller survey of the continent is required before true reserves can be estimated. A. C.

**1078. Petroleum Activities in Colombia.** E. Ospina-Racines. *Bull. S. Amer. Inst. Pet.*, 1946, **2**, 275–284.—During 1945 47 new wells were started and 63 completed. 8 companies were developing concessions and over 19 million brl exported. Detailed production figures are given. A. C.

**1079. Debate Over Concession where New Czechoslovakia Producer is Located.** Anon. *Oil Wkly*, 1.4.46, **121** (5), 49 (International Section).—A field, discovered in 1945, near Zizkow, just north of Lundenburg in Moravia, is the first area which might potentially meet a substantial part of Czechoslovakia's needs. The field is in an extension of Austria's Vienna Basin, in which lies Zistersdorf. Four wells have been completed, defining reserves of 7,000,000 brl.

The matter of the concession is under discussion, since an agreement had been reached regarding a contract with an American-owned company before the German occupation. G. D. H.

**1080. French Production.** Anon. *Oil Wkly*, 11.3.46, **121** (2), 78.—In September 1945 Pechelbronn was producing 925 brl/day. A year earlier the figure was 1250 brl/day. G. D. H.

**1081. Arabian American Output Doubled in Year's Time.** Anon. *Oil Wkly*, 1.4.46, **121** (5), 49 (International Section).—In 1945 the Arabian American Oil Co. produced about 21,300,000 brl of oil in Saudi Arabia. The 1944 production was 7,800,000 brl. The new refinery at Ras Tanura was completed in December 1945, and has a 60,000-brl/day throughput. G. D. H.

## Transport and Storage.

**1082. Measurements of Friction in a Pipe for Subsonic and Supersonic Flow of Air.** J. H. Keenan and E. P. Neumann. *J. Appl. Mech.*, June 1946, **13** (2), A91–A100.—The apparent friction coefficient was determined experimentally for the flow of air through smooth pipes at subsonic and supersonic velocities. Values of the Mach number ranged from 0·27 to 3·87, and of Reynolds number from $1 \times 10^5$ to $8·7 \times 10^5$. In supersonic flow the results were found to be strongly influenced by the presence of oblique shocks formed at the junction of nozzle and pipe. The effect of these shocks on the coefficient of friction was determined. Nozzle forms were devised which eliminated the shocks and their effects. It was found that at distances from the pipe inlet greater than 50 diam the apparent coefficient of friction for compressible flow at Mach numbers greater or less than 1 is approximately equal, for equal Reynolds numbers, to the coefficient of friction for incompressible flow with completely developed boundary layer. Mach numbers greater than 1 are rarely maintained for lengths greater than 50 diam. For attainable lengths the coefficient of friction is a function of the ratio of length to diameter and the Reynolds number, with the Mach number at entrance determining the maximum attainable length. A. H. N.

**1083. On the Velocity Distribution of Turbulent Flow in Pipes and Channels of Constant Cross Section.** C. Wang. *J. Appl. Mech.*, June 1946, **13** (2), A85–A90.—This paper follows the Prandtl conception of momentum transport and gives a critical examination of the so-called Prandtl–Nikuradse formula and the von Karman formula for the velocity distribution of the turbulent flow in tubes or channels at large Reynolds number. It shows that both formulæ would not give a good picture of the turbulent flow near the centre of the conduit, and they actually do not. A new formula for the velocity distribution is developed from a study of the mixing-length distribution across the section. This new formula checks quite well with the experiments, and yields the same skin-friction formula as derived by von Karman and Prandtl, which itself is in very good agreement with experiments. A. H. N.

**1084. 1946 Pipeline Construction Programme—One of the Largest in Peacetime History.** *Oil Gas J.*, 27.7.46, **45** (12), 159.—Tabulated data are given of pipeline projects for 1946, which show the lines planned, completed, and under construction in the United States, for (1) major products; (2) natural gas transmission lines; and (3) new and expanded crude oil lines for the first half of the year. The data show the company, mileage, size, and location. The total mileage covered and the size of the line shown for (1) is 2014, (6–8 inch); (2) 4125, (12–25 inch); (3) 1495, (6–10 inch).

In Europe, Asia, and the South Americas the following construction is shown. In the U.S.S.R., natural gas lines: (1) of about 300 miles, from the Western Ukraine to Kiev is under construction; (2) from Saratov to Moscow, about 500 miles is nearing completion, a parallel line is also planned. A crude-oil line is nearing completion which will serve a refinery at Ufa from the oilfields at Tuimazy. In the Middle East a Trans-Arabian pipeline is being planned for the Trans-Arabian Pipe Line Co., Standard of California and Texas Co., extending 1000 miles from the Persian Gulf to the Mediterranean coast.

In South America, the Bolivian Government Oilfields 6-inch pipeline will transport crude from Camiri to Tintin, a distance of 255 miles, and it is reported the plan will include a products line between Camiri and Sucre, of about 186 miles. In Venezuela, the Lake Maracaibo producers are considering the construction of a new big-inch line from the fields to the Paraguana Peninsula. Several companies are contemplating the building of a line from Puerto Cruz to near Las Mercedes, in the State of Guarico, E. Venezuela. It is reported that the Mexican Government is planning for a new line for crude oil from the Poza Rica field to Salamanca. The Government also plans for a transmission system to convey 35 million cu. ft. natural gas per day for supplying the industrial needs of Mexico City. The Gas Industry de Monterrey is planning the construction of a line 140 miles long to convey gas from Hildalgo-Reynosa for serving Northern Mexico. Negotiations are under way with the Reynosa Pipe Line Co. to build a 30-mile line from near Weslaco Texas to the International Bridge.

W. H. C.

**1085. Far Eastern Oil Picture Clarifying; Numerous Changes under Way.** W. W. Burns. *Oil Gas J.*, 6.7.46, **45** (9), 60.—The first of a two-part discussion of the restoration of the peace-time rôle of oil in the Far East.

In the Philippines, oil distribution is now being handled by the Pacific Oil Storage Co., guided by the military authorities. Storage capacity at Bataan is about 400,000 brl, and is to be increased to 920,000 brl, storing aviation and motor gasolines, diesel oil, kerosine, and range oil. A drum plant is to be constructed. A scarcity in oil-barge and tankers exists, vessels having been sent to China.

As for China, the policy of its Government regarding movements of foreign-flag vessels is unknown. Vessels intended for the Chinese Government have not been handed over, because it is not yet ready to operate them. The country's petroleum industry is to be developed by the Government. Foreign oil companies are ready to resume pre-war distribution operations.

In Korea, the political situation with the important oil installations in the hands of the Russians, coupled with the financial insolvency of Korea economy, makes private oil-company operations impossible for many years to come. It is thought that normal operation in Japan is likely to be delayed beyond 1948, but plans have been made for the commercial companies to operate. G. A. C.

# Refinery Operations.

## Refineries and Auxiliary Refinery Plant.

**1086. Modern Refining Processes, Part 10.—Refinery Losses—Where they are and How to Reduce Them.** G. Armistead. *Oil Gas J.*, 13.7.46, **45** (10), 108.—Refinery losses are classified, and the main sources are shown in a diagram indicating the stages in which they occur from the receipt of the crude oil and through the storage, processing, refining, and blending stages to the transfer of products from the refinery for marketing, the various losses being discussed under the following sections: unloading and loading losses; line and vessel leaks; condensing and cooling losses; evaporation losses; processing losses. Losses are classified as: (*a*) evaporation and other escape into the atmosphere; (*b*) loss through plant-water effluent; (*c*) miscellaneous losses, such as incomplete emptying of tank cars, acid sludge losses, etc.; (*d*) loss through leakage into the soil. Economic losses are noted—*i.e.*, high-value products that may gain admittance to low-value products, and, though no actual loss occurs, a financial loss results. Weight balances are discussed, and one is shown in a typical over-all monthly refinery weight balance for a 5000 brl/day refinery employing thermal and catalytic cracking. The weight balance shows only the extent to which total input to a given system is accounted for, and does not indicate the avenue of any loss or losses thus detected, although pointing out their magnitude. The basic requirement for the control of refinery losses and the maintenance of the maximum economic liquid recovery is the provision of a routine continual check on possible losses, and the provision of adequate means for making such detailed investigations as are indicated as necessary. By such means the over-all unaccounted-for loss should not exceed about 1%, and for an individual unit should be somewhat lower. Eight literature references are given.

W. H. C.

**1087. Steam and Power Generation in the American Refinery.** W. F. Ryan. *Oil Gas J.*, 6.7.46, **45** (9), 76.—The Louisiana Station power-plant is described in this Part (2) of the article.

This plant is situated at Baton Rouge, and is now owned and operated by the Gulf States Utilities Co., as part of their system.

Originally built in 1930, it contained three 15,000-kW turbine generators operating at 600 psi and 750° F and exhausting at 141 psi to deliver 135 psi steam to the refinery. Capacity has now been increased to 123,500 kW with 7 turbine generators and 8 boilers of more than 3 million lb/hr total capacity, with no change in operating pressure or temperature.

The water-treating plant precipitates 15–20 tons of mud and silt per day from 4 to 5 million gal of Mississippi River water, and cost $850,000.

Water is drawn through two 16-inch siphon pipes into a 60-ft deep well, equipped with 3000 g.p.m. motor-driven deep well-type pumps. The clear water is pumped through zeolite softeners to the boiler-feed system, which includes a 200,000-gal reserve tank.

The boilers are equipped to burn 10 or 12 different fuels, including natural and refinery gas, fuel oil, acid sludge, pitch bottoms, and other refinery wastes.

Desuperheating of the exhaust to meet refinery requirements is accomplished by passing the exhaust from the turbines through a throughfare desuperheater, thus eliminating supplying turbine by-passed steam to the refinery. Since more steam is passed through the turbine, the yield of by-product power is increased, more than 45 kWh/1000 lb of process steam delivered being obtained. Total blow-down exceeds 500,000 lb/hr at certain river stages; a heat exchanger replaces the original flash-tank. This, together with the use of a "house-turbine" to replace the reducing valve on the 135 psi mains to the 5 psi auxiliary exhaust system, has played a part in effecting an increase of 25% yield of by-product power.

G. A. C.

**1088. Plant Requirements Dictate Design for Steam and Power Generation in the American Refinery. Part 3.** W. F. Ryan. *Oil Gas J.*, 13.7.46, **45** (10), 85.—A noteworthy advance was made in 1941 in steam and power generation for refineries

when public-utility installations were designed, and built by the Pacific Gas and Electricity Co. for the refineries of the Tide Water Associated Co. at Avon; the Shell Oil Co. at Martinez; and the Union Oil Co. at Oleum in California. The three installations are basically the same in design. Details are given and the set-up is shown by a photograph and in a flow diagram, and a sectional drawing shows the high- and low-pressure turbines. Each installation includes 3 boilers each having a capacity of 230,000 lb/hr steam at 1525 psi and 940° F serving the H.P. turbine, exhausting at 225 psi, part of this going to the L–P turbine. The combined power generates 43,500 kW. The balance of the H–P exhaust steam flows in a closed circuit through a heat exchanger and an evaporator condenser in series, passing out as H–P condensate at 392° F, to a boiler feed-heater, which also receives the condensate from the L–P turbine exhaust in a second closed circuit after preheating by exhaust steam from auxiliaries. In this way, the feed-heater cycle provides deaerated boiler feed-water at 397° F. The heat-exchanger and the evaporator condenser mentioned, contain an open circuit in which preheated treated water is fed to the vaporizer condenser, and is vaporized and passed to the heat-exchanger, in which it is superheated, giving steam at 145 psi for refinery processing. The merits and disadvantages of this system are discussed. A plant designed and installed in Persia in which salt water is used is described, and a heat-balance flow diagram shows its construction and operating characteristics. No records of steam and electric power-generating plants are available for plants constructed during the war. A new installation is mentioned; it is designed for temperatures and pressures approximately as those above, and to use treated water. The elimination of the evaporator cycle will materially increase the yield of by-product power, but the water-treating plant may cost $1,000,000, and a continuing problem in operating will be incurred. The co-ordination of refinery processes with power generation is discussed, and pertinent issues in refinery economics are brought forward showing the intimate relation between refinery processes and power generation, and emphasizing the opportunity for highly specialized design in this connection. The possibilities of extending heat exchange appear to lie entirely in the direction of producing steam from the waste heat of the various process plants. The exchange of waste heat from refinery liquids, flue gases, etc., from tube-stills or cracking units, is elaborated, and a typical arrangement for generating steam in tube-stills is described. Briefly, a boiler drum is fitted adjacent to the tube-heater, to which preheated boiler feed-water is introduced. The water flows through a nest of heating tubes situated in the lower part of the convection bank of the tube-heater, the flow being upward and counter current to the flue gases, and back to the drum, where the steam and water are separated. W. H. C.

**1089. Fin-Tube Exchanger Units. Refiner's Notebook No. 99.** W. L. Nelson. *Oil Gas J.*, 29.6.46, **45** (8), 127.—Double-pipe heat exchangers in which inside flow tubes have longitudinal fins give high over-all transfer rates when the low-film-rate fluid is passed on the fin side of the exchanger. For computing the film transfer rate on the fin side of the tube, use can be made of the chart given in *Refiner's Notebook No.* 91 (Abstr. 783), constructed for flow inside plain tubes, supplemented by a correction for the conduction due to increased area of the fins. This—*i.e.*, the " equivalent " fin-side area—is described, and can be obtained from the chart here presented. Examples are given and solved by the use of the two charts mentioned, and/or by using the latter with one of the charts given in *Refiner's Notebook* No. 94 or 95. The method of computing the pressure drop in fin-tube exchangers is outlined. W. H. C.

**1090. Pressure Drop Through Tube Bundle of Exchanger.** W. L. Nelson. *Oil Gas J.*, 22.6.46, **45** (7), 129.—Issue 98 of the *Refiner's Notebook* gives a chart, drawn by means of the Fanning equation for turbulent flow, from which the friction loss of a fluid flowing through the tube bundle of an exchanger can be estimated. Three examples are given. G. A. C.

**1091. Pressure Drop Through Tube Side.** W. L. Nelson. *Oil Gas J.*, 15.6.46, **45** (6), 137.—No. 97 in the *Refiner's Notebook* series gives a table showing in-and-out pressure drop per pass for typical conditions through exchanger tubes; a chart is provided for use with $\frac{3}{4}$ and $1\frac{1}{4}$-inch tubes.

Specific gravity at the film temperature is an important factor. Friction loss through other sizes can be interpolated from the chart. G. A. C.

**1092. Anchor Bolt Calculations.** S. M. Jorgensen. *Refiner*, 1946, **25** (5), 97–101.—An evaluation of stresses in anchor bolts and between base-plate and foundation is arrived at by comparison with stresses in a reinforced beam subject to an eccentric axial load in a plane of symmetry. Formulæ are developed and the method of application is set out, including cases involving slender towers with large overturning moments. G. R. N.

**1093. Do You Get 90 Per Cent Salt Removal?** F. D. Fuqua. *Oil Gas J.*, 13.4.46, **44** (45), 105.—The method of desalting Oklahoma crude oils as practised at the Ben Franklin Refinery, Ardmore, and the plant system used for charging 3000 brl/day are described and shown by a flow diagram. The procedure is conventional in form, as it entails the introduction of fresh water to the crude, emulsification, and de-emulsification, but close attention must be given to the following operating conditions: maintaining the proper pressure drop across the emulsifying valve; holding the most suitable temperature within the settler to break the emulsion; maintaining sufficient back pressure to prevent vaporization in the system; close control of the fresh water to maintain the desired brine concentration in the settler; close control of the volume of chemicals added. The results of desalting trials are discussed and typical operating data are tabulated of desalting at various pressure drops and temperatures. Pressure drop is probably the most critical of all variables. With minimum pressure drop salt removal is poor, ranging from 60–80% salt removal, a 40–50 psi differential across the emulsifying valve seems ideal for the crudes in question, but 75–100 psi is not so reliable. This is shown in the graphs of pressure drop in relation to salt content of the final treated crude, and in the pressure drop *vs.* salt removal. Temperature must be high enough to reduce the surface tension of the oil to the point that water will break out. Assuming that surface tension is a direct function of viscosities, temperature–viscosity curves of each crude have been plotted and projected. It appears from these that an S.U. viscosity of approximately 40 sec or less in the crudes must be reached to obtain optimum salt removal. The importance of maintaining low viscosity and the quantity of water added and the brine concentration are discussed. No bad effects from the presence of solids have been found; apparently all solids are discarded with the water drawn from the vertical settler. A definite advantage, however, is assumed in the contact coalescing value of suspended solids when present in the emulsion. Settling time is discussed, and a table shows the emulsion "break" obtained in normal operations which gives the settling time and amount of water found at various points in the system. Contact coalescing is discussed. The baffle section is intended to create a turbulent flow and a contact surface to coalesce, so far as possible, the droplets of water before they reach the vertical settler. Also, if any salt still remains coated with a paraffin sheath, the additional contact in this hot section tends to break down final resistance before entering the vertical settler. The salt-removal system described secures 90%, or more, salt removal at a cost for chemicals of less than two mills per barrel of crude processed. W. H. C.

**1094. British Aviation Fuel Manufacture in the Middle East. Part I. Research and Development.** Anon. *Industr. Chem.*, 1946, **22**, 468–475.—An account is given of the increase in production from 25,000 Imp. gals/day of 87 octane no. aviation fuel in 1939 to 1 million gals/day of 100/130 grade and 130,000 gals/day of 87/90 grade in 1944 at the Abadan Refinery of Anglo-Iranian Oil Co., Ltd. The development of engines and engine testing is briefly traced, together with the production control methods used. F. S. A.

## Distillation.

**1095. Questions on Technology.** W. L. Nelson. *Oil Gas J.*, 22.6.46, **45** (7), 127.—The Distex process is described with a simplified flow diagram. This process is a combination of distillation and extraction for separation of hydrocarbons where plain fractionation is not practicable. A solvent such as aniline, phenol, or chlorex is introduced as a scrubbing agent near the top of the column during distillation, and

appears at the bottom mixed with the high-boiling product. The solvent alters the vapour-pressure characteristics of the hydrocarbons so that their boiling points are spread out. The solvent is recovered by stripping and recycling. G. A. C.

## Absorption and Adsorption.

**1096. High-Pressure Absorption.** H. F. Wade. *Refiner*, 1946, **25** (5), 92–96.—A discussion on the general factors affecting absorber pressure, the effect of it on compressor horsepower and on plant cost, and its limitations in connection with the development of high-pressure natural gas resources. G. R. N.

## Cracking.

**1097. Cycle Stocks from Catalytic Cracking.** C. L. Brown, A. Voorhies, junr., and W. M. Smith. *Industr. Engng. Chem.*, 1946, **38**, 136–140.—Hydrogenation of the aromatic constituents in refractory catalytically cracked, cycle stocks to their corresponding naphthene derivatives results in improved catalytic-cracking feed-stocks which are superior even to the original virgin gas oils. Hydrogenation conditions used are generally the same as for the conventional high-pressure destructive hydrogenation of gas oils directly to gasoline, except for the catalyst, which, similarly, is sulphur resistant. Yields of hydrogenated cycle stock are 100% or more in all cases, with little change in boiling range and virtually complete sulphur removal. A combination of catalytic cracking with hydrogenation of all cycle stock and recracking to ultimate gasoline yield, combined with the fullest utilization of light hydrocarbons ($C_3$, $C_4$, $C_5$) by isomerization, alkylation, etc., is shown by calculation to result in an over-all volumetric yield of over 90% of 100-octane gasoline. Lower pressures (750 compared to 3000 psi gauge) result in partial saturation of aromatics with rather complete desulphurization. A. W.

**1098. Simplicity and Flexibility of Thermofor Catalytic Cracking.** H. D. Noll, K. G. Holdon, and E. V. Bergstrom. *Refiner*, 1946, **25** (5), 123–129.—A small T.C.C. unit is here proposed as one means whereby operators of small refineries may meet the problem of producing higher yields of quality gasoline at a reasonable manufacturing cost and provide ample allowance for further increases in quality should the competitive situation so demand. Discussed is a small-scale integral T.C.C. unit designed to process from 1000 brl/stream day upward of virgin charging stocks ranging from heavy naphthas to vacuum distillates. The unit is characterized by high yields of high-quality product at high liquid recoveries with low investment cost and low operating and maintenance costs. The integral design and simplicity of construction details make for a high percentage of on stream time. G. R. N.

## Polymerization.

**1099. Modern Refining Processes.—Part 11. The Gas Reversion and Polyform Processes.** G. Armistead. *Oil Gas J.*, 27.7.46, **45** (12), 189.—The gas reversion or polyforming process as usually practised is a high-pressure, coil-only thermal operation in which a stream of $C_3$ and/or $C_4$ hydrocarbons is passed with the oil feed through a cracking coil for the purpose of (1) Effecting polymerization of the $C_3$ and $C_4$ hydrocarbons to others of gasoline boiling range; (2) Effecting alkylation and other interaction between the light stream and the oil feed undergoing cracking, including reactions such as cyclization; (3) Dilution of the oil-feed so as to permit more severe conditions and increased extent of conversion. A distinction is drawn between gas reversion and polyforming, the former being an operation in which the light hydrocarbon stream is separately cracked, in part, before being mixed with the partly cracked stream of heavier material. In the polyforming operation the light and heavy stocks are first mixed and then passed through the cracking coil.

Conventional naphtha polyforming is described and shown in a flow-sheet, the heavy naphtha is passed through a high-pressure absorber, in which it is contacted with stabilizer gases and absorbs the desired amounts of butane–butylene and propane–propylene, the enriched naphtha being passed to the cracking coil operated at up to

1150° F and up to 2000 psi. The reacting time is from 0·05 to 0·08 cu. ft of coil volume, per barrel, per day naphtha throughput. The stream from the furnace is quenched en route to the separating column, in which any polymerized tar is removed; the light products pass overhead to the stabilizer, from which stabilized cracked gasoline flows as bottoms, and the light gases pass overhead to the absorber for recycling. Control of the amount and character of the light hydrocarbons for recycling is done in the stabilizer and absorbing sections. The recycle ratios of the composite stream are governed largely by the individual conversion characteristics of the propane and butane. These points are discussed.

Recycle ratio is also related to the obtainable ultimate yield, increase in recycle ratio giving increase in ultimate yield, but lower resultant octane level because of the reduced severity and conversion per pass. The gas-reversion operation is described and shown in a flow diagram of a combination crude and gas-reversion cracking unit. This carries out naphtha reforming, single-pass viscosity breaking and gas-oil cracking.

The unit comprises two furnaces having (1) crude oil heating and naphtha reforming coils; (2) gas-oil cracking and viscosity-breaking coils; all exits, except the crude coil, leading to the separator, a fractionator and stabilizer and absorber, in series. The crude-coil exit leads to a conventional fractionator from which the reduced crude is pumped to the viscosity-breaking coil, the exit of which has a connection for quenching the stream by cycle gas oil from the bottom of the intermediate fractionator. The light hydrocarbons from the reforming coil are recovered and used as described above; but in this unit the $C_3$ and $C_4$ cut may be separated as a condensate from the stabilizer overhead and pumped (1) with the feed to the gas-oil cracker and (2) with the reduced crude fed to the viscosity-breaking coil. The dilution thus made effecting increased cracking per pass and retarding coking.

Cracking pressures of 1000–3000 psi and temperatures up to 1150° F are employed. The fractionating system is operated at 250–400 psi to give the desired light hydrocarbons. The dilution ratio (oil feed : recirculated $C_3$ and $C_4$) used is generally around 1 to 1·5. A graph shows the trend of yield-octane relationships for a number of low-octane heavy naphthas when effecting the maximum obtainable recovery of $C_3$ and $C_4$ hydrocarbons and recycling them to extinction. The mechanism of these processes is discussed. The quantities of aromatic hydrocarbons produced, including toluene and xylenes, are sufficient to warrant the commercial separation of the individual compounds. W. H. C.

**1100. Meeting of the Division of Rubber Chemistry, High Polymer Forum, and Divisions of Paint, Varnish and Plastics, Cellulose, Colloid, Organic, and Physical and Inorganic Chemistry of the American Chemical Society, April 9–10, 1946.** *India Rubber World*, 1946, **114** (2), 221–228.—Abstracts of papers read before this meeting are given, the following titles being of most interest: "Research leading to Commercial Butadiene Synthetic Rubber" (W. L. Semon) (Charles Goodyear lecture for 1944), "Disorder in Linear Condensation Copolymer Solids" (C. S. Fuller, W. O. Baker), "Relative Activities of Ethylene Derivatives in Copolymerization" (F. R. Mayo), "Some Recent Results in the Field of Copolymerization" (T. Alfrey), "Partial Conversion Properties of Copolymers" (F. T. Wall), "Copolymerization of Vinyl Compounds with Dienes" (A. Goldberg, T. Alfrey, W. P. Hohenstein), "Copolymerization" (I. Skeist), "Viscosity of Dilute Solutions of Long-Chain Molecules" (M. L. Higgins), "Thermal Polymerization of Methyl Methacrylate" (C. Walling, E. R. Briggs), "Temperature Dependence of Osmotic Pressure of Polyvinyl Chloride Solutions" (P. Doty, E. Mishuck), "General Theory of Emulsion Polymerization with Respect to Reaction Loci" (W. D. Harkins), "Thermal Polymerization of 2-Vinyl-Naphthalene" (J. M. Grim, W. E. Baldwin, W. H. Hill), "Chain Transfer in Polymerization of Styrene" (R. A. Gregg, F. R. Mayo), "Degradation of Vinyl and Diene Polymers" (R. B. Mesrobian, A. V. Tobolsky), "Polytetrafluoroethylene, a New, Heat-Resistant, Chemically Inert Plastic" (M. M. Renfrew, E. E. Lewis), "Vinyl Alkyl Ethers" (C. McKinley, C. E. Schildknecht, A. O. Zoss), "Copolymerization in Suspension (Pearl Copolymerization)" (W. P. Hohenstein, F. Leonard), "Properties of Monomeric and Polymeric Alkyl Acrylates and Methacrylates" (C. E. Rehberg, C. H. Fisher), "Investigation of Polymerization of Styrene with a Low Temperature Calorimeter" (F. G. Brickwedde), "Electrical Properties of Butyl Rubber" (I. C. Eaton, A. V.

Roberts, E. E. Sheldon), "Polymerization of *p*-Chlorostyrene in the Presence of Polymethyl Acrylate" (R. B. Carlin, N. E. Shakespeare). C. N. T.

## Physical Refining.

**1101. Pure Hydrocarbons from Petroleum.** J. Griswold, D. Andres, C. F. Van Berg, and J. E. Kasch. *Industr. Engng. Chem.*, 1946, **38**, 65–71.—The Distex or extractive distillation process is described, with its application to the separation of straight-run fractions consisting of paraffins, naphthenes, and aromatics. The process differs from azeotropic distillation in that the boiling point of the solvent used is well above that of the hydrocarbons being separated, its purpose being to spread the volatilities of the close-boiling hydrocarbons. The effectiveness of several solvents for paraffin-naphthene separation has been evaluated from vapour–liquid equilibrium data using heptane and methyl *cyclo*hexane. Details are then given of the apparatus and procedures used to resolve a narrow-boiling $C_8$ petroleum fraction using aniline—one of the most effective solvents. The results obtained indicate that the Distex operation is effective and feasible for the separation and preparation of pure hydrocarbons from the three hydrocarbon groups present in light petroleum fractions. A. W.

**1102. Pure Hydrocarbons from Petroleum.** J. Griswold and C. F. Van Berg. *Industr. Engng. Chem.*, 1946, **38**, 170–177.—The Distex process has been applied to the separation of a narrow-boiling heptane fraction from petroleum. The pilot plant used is described in detail, together with its performance at different reflux ratios in separating the heptane fraction into paraffinic, naphthenic, and aromatic portions. Pure heptane was obtained from the paraffinic portion by batch fractionation. A. W.

**1103. Some Developments in the Refining of Transformer Oils.** J. C. Wood-Mallock. *J. Inst. Petrol.*, 1946, **32**, 365.—The requirements of transformer oils are listed as high insulation resistance, high dielectric strength, high specific inductive capacity, low loss factor, high heat conductivity, high heat capacity, low freezing or set point, low volatility, low viscosity, low water tolerance, high resistance to chemical or physical change, particularly under oxidizing or hydrolysing conditions, passivity to copper and cellulose. The methods used to attain these requirements are studied.

A. H. N.

## Special Processes.

**1104. The Cracking of Middle Oil from the Fischer Tropsch Process.** F. E. T. Kingman and C. M. Cawley. *Petroleum*, 1944, **9**, 126–128.—Fractions of the oil product of the Fischer–Tropsch synthesis readily undergo cracking to yield liquid and gaseous olefins. Thus, the middle oil fraction may be thermally cracked at about 600° C to yield liquid hydrocarbons containing 80–90% of olefins and gaseous hydrocarbons containing 60% of olefins. The nature as well as the yield of products may be modified to some extent by the use of a cracking catalyst.

This paper describes an investigation the main object of which was to find whether the cracking of Fischer–Tropsch oil would yield liquid olefins suitable for the preparation of lubricating oil by polymerization. The results given deal chiefly with factors affecting yield. The properties of the olefins themselves and their behaviour on polymerization will be dealt with in a separate paper.

The middle oil fraction submitted to thermal cracking boiled between 200° and 300° C. A vertical, electrically heated tube having a reaction space of 35 ml was used. The cracking temperature varied between 570° and 635° C and the throughput from 40 to 110 g per hour. The reaction times under these conditions varied from about 30 to 10 seconds.

At 635° C and a throughput of 90 g per hour the total yield of liquid product was 67·6% by weight of the original oil with a yield of spirit to 200° C of 20·4% (also based on the original oil). Recycling the oil boiling above 200° C gave a total yield of 37·8% of spirit to 200° C (bromine number 130) and a yield of gas of 39·3 litres per 100 g of raw material. The spirit to 170° C had a bromine number of 148 and contained approximately 80–90% of olefins with less than 2% of aromatics.

The gaseous product from thermal cracking contained only a small proportion of

hydrogen; the olefins, which increased from 57% at 570° C to 63% at 635° C, consisted mainly of ethylene and propylene with a smaller proportion of butylene and a very small amount of butadiene.

The use of a catalyst consisting of mixed alumina and silica increased the yield of gas and had a marked effect on the nature of the products. The spirit had a lower olefine content and a higher content of both aromatic and saturated hydrocarbons. The gas contained a greater proportion of hydrogen; the proportion of total olefins was not greatly changed, but the catalyst favoured the production of propylene and butylene in place of ethylene, and the formation of butadiene was completely suppressed.

K. C. G. K.

**1105. Synthetic Fuels in Germany: (2) Hydrogenation.** *Petroleum*, 1946, **9**, 102.—A summary of German hydrogenation plants is given in tabular form; 15 plants being included.

Separate sections deal with the hydrogenation of coal and tar, vapour-phase hydrogenation, the D.H.D. process, and finally the production of iso-octane and alkylate.

K. C. G. K.

**1106. Synthetic Fuels in Germany, 3 (1). Fischer–Tropsch Process, Lubricating Oils, and Acetylene.** *Petroleum*, 1946, **9**, 158.—The Fischer–Tropsch process yields a diesel oil of high cetane number. During the war this was blended with tar from the low-temperature carbonization of brown coal and used in farm tractors and heavy trucks. The spirit produced has a low octane number (about 50), but was used for motor transport. The butane fraction was compressed and also used for driving vehicles.

The paraffin wax was also utilized. The operation of the plants was varied as required to give the range of products desired.

The gas for the process should be a mixture of two parts of hydrogen to one part of carbon monoxide. The catalyst used is very sensitive to sulphur, which was removed as far as possible by washing first with ammonia and then passing through a mixture of iron oxide and sawdust (to remove hydrogen sulphide). Organic sulphur was removed in towers filled with an iron oxide–sodium carbonate catalyst at 200–300° C.

Important features are the design of the reaction vessels and the method of manufacturing the catalyst. The reaction is highly exothermic, but the temperature must be held at about 200° C. Each of the 24 reaction vessels at the Carrières–Kuhlmann plant (Harnes, France) consisted of 600 baffles pierced by 600 tubes, the space between tubes and baffles being filled with catalyst. Water under pressure flowed through the tubes, its temperature being controlled by the steam pressure in the system. The gases passed through 16 vessels arranged in parallel, and the effluent was cooled. After separating the condensate, the gases passed through the other 8 vessels arranged in parallel.

The catalyst used at Harnes consisted of: cobalt = 18%, magnesium oxide = 1·8%, thorium oxide = 0·9%, kieselguhr = 79·3% by wt. Cobalt and thorium were recovered from the used catalyst.

The O.X.O. Process.—This was used to manufacture higher alcohols from Fischer–Tropsch olefines, for use in soap-making. $C_{11}$–$C_{17}$ olefines are passed with sulphur-free water-gas over ordinary Fischer-Tropsch synthesis catalyst. The aldehydes formed are hydrogenated by passage with pure hydrogen over a nickel catalyst.

K. C. G. K.

## PRODUCTS.

### Chemistry and Physics.

**1107. Heats of Combustion and Formation at 25° C of the Alkylbenzenes through $C_{10}H_{14}$, and of the Higher Normal Monoalkylbenzenes.** E. J. Prosen, W. H. Johnson, and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, 1946, **36** (5), 455.—Values are given for the heats of combustion (in oxygen to form gaseous carbon dioxide and liquid water) and the heats of formation (from the elements, solid carbon (graphite) and gaseous hydrogen), at 25° C, for benzene, toluene, the four $C_9H_{10}$, the nine $C_9H_{12}$, and the

twenty-two $C_{10}H_{14}$ alkylbenzenes, in both the liquid and gaseous states, and for the higher normal monoalkylbenzenes in the gaseous state.

The method of calculation used is described, and the constants on which the calculations are based are given. Previous experimental data on heats of combustion of the alkylbenzenes are compared with the selected "best" values obtained from this work. A full bibliography is appended. T. M. B. M.

**1108. Heats of Combustion of Four *cyclo*Pentane and Five *cyclo*Hexane Hydrocarbons.** W. H. Johnson, E. J. Prosen, and F. D. Rossini. *Bur. Stand. J. Res. Wash*, 1946, **36** (5), 463.—The heats of combustion of *cyclo*pentane, methyl*cyclo*pentane, ethyl*cyclo*pentane, *n*-propyl*cyclo*pentane, *cyclo*hexane, methyl*cyclo*hexane, ethyl*cyclo*hexane, *n*-propyl*cyclo*hexane, and *n*-butyl*cyclo*hexane have been measured with a bomb calorimeter. Values are given for $-\Delta Hc^{\circ}_{298\cdot16}$, the heat of combustion at 25° C, and constant pressure of the liquid hydrocarbon in gaseous oxygen to form gaseous carbon dioxide and liquid water, with all the reactants and products in their thermodynamic standard reference states, in international kilojoules, per mole, and also in terms of the conventional thermochemical calorie.

A bibliography is appended. T. M. B. M.

**1109. Dehydroisomerization of *n*-Butane.** H. S. Bloch and R. E. Schaad. *Industr. Engng. Chem.*, 1946, **38**, 144–147.—The conversion of *n*-butane into a mixture of *n*-butylenes and isobutylenes has been carried out at atmospheric pressure with a catalyst comprising a dehydrogenating component (chromia–alumina) and an olefin-isomerizing component (silica–alumina–thoria). A catalyst bed composed of a mixture of granules of the two components was much more effective than a bed of granules made of the mixed powders. Under the most favourable conditions (525–575° C, gaseous hourly space velocities of 1500–1200) butylene yields of 25–30% were obtained with a dehydrogenating efficiency of approximately 85%. About one-fourth of the yields of butylene was isobutylene. A. W.

**1110. Conversion of *n*-Heptane to Isobutane.** O. Grummit, E. N. Case, and C. V. Mitchell. *Industr. Engng. Chem.*, 1946, **38**, 141–144.—Experiments with water- or hydrogen chloride-promoted aluminium chloride and *n*-heptane, with and without the addition of sodium, magnesium, or aluminium, have been run at 95–100° C and atmospheric pressure to determine the yields of isobutane, light paraffins ($C_3$–$C_7$), heavy paraffins ($C_8$ and higher), and the oil from the catalyst complex. These metals exert a very marked influence on the promoted catalyst as shown by decreased conversions, increased isomerization to light paraffins, and decreased cracking-isomerization to isobutane and oil. Because aluminium has the greatest effect in retarding oil formation, which inactivates the catalyst, it is the best of the three metals tested for controlling this reaction as a route to the production of isobutane and of light paraffin hydrocarbons. A. W.

**1111. Catalytic Conversion of Hydrocarbons.** F. E. Fisher, H. C. Watts, G. E. Harris, and C. M. Hollenbeck. *Industr. Engng. Chem.*, 1946, **38**, 61–64.—The activity of the catalyst in the catalytic aromatization of aliphatic hydrocarbons was improved to an appreciable extent by the addition of antimony tetroxide to the chromia–alumina catalyst. The aromatization reaction was carried out on three different types of charge stocks: a heptane fraction from a natural gasoline, a heavy straight-run gasoline, and a thermally cracked gasoline. The reaction temperature was about 550° C, and both the liquid and gaseous products were analysed. The production of aromatics during any one reaction period increased through a maximum, and then decreased. The yield of gaseous products paralleled the formation of aromatics until excessive cracking superseded the dehydrogenation-cyclization reaction. A. W.

**1112. Hydrogen Fluoride–Paraffin Systems.** E. B. Butler, C. B. Miles, and C. S. Kuhn. *Industr. Engng. Chem.*, 1946, **38**, 147–155.—Mutual solubilities of low-molecular-weight hydrocarbons (isobutane, *n*-butane, propane) and of hydrogen fluoride in two liquid-phase systems, with and without water and alkylate, were determined for the range 0–50° C, with alkylate concentrations up to 30% wt in the hydrocarbon phase,

and water contents up to about 10% wt in the acid phase. Anomalous solubilities of isobutane in the presence of alkylate and water are considered to be related to the greater alkylating activities of isoparaffins. Tentative correlations of the data with analyses of plant streams are presented. A. W.

**1113. Vapour-Liquid Equilibria of Binary Hydrocarbon Systems.** J. M. Harrison and L. Berg. *Industr. Engng. Chem.*, 1946, **38**, 117–120.—Six close-boiling binary hydrocarbon systems have been investigated. Minimum azeotropes exist between 2 : 2 : 3-trimethyl butane–benzene, boiling at 75·6° C at 736 mm, and containing 56·7 mole-% benzene; between 2 : 2 : 3-trimethyl butane–*cyclo*hexane, boiling at 79·45° C at 744 mm, and containing 47·8 mole-% 2 : 2 : 3-trimethyl butane; and between benzene-*cyclo*hexene boiling at 78·9° C at 740 mm and containing 65·7 mole-% benzene. No azeotrope was found in the systems 2 : 2 : 4-trimethyl pentane–methyl *cyclo*hexane and *cyclo*hexane–*cyclo*hexene. A. W.

**1114. Boiling Point Relations Among Mononuclear Aromatics.** H. Corbin, M. Alexander, and G. Egloff. *Industr. Engng. Chem.*, 1946, **38**, 147–155.—The variation of boiling point ($t$) with the number of carbon atoms ($n_c$) has been determined for 10 homologous series of mononuclear aromatic hydrocarbons leading to equations which are all of the form :

$$t = \text{a log } (n + 4{\cdot}4) + K$$

The variation of the difference in boiling point ($\delta$) between an aliphatic compound and its phenyl derivatives with the number of carbon atoms has been determined for 9 homologous series giving equations all of the form :

$$\delta = p + q \log n_c$$

Comparisons have been made among phenylalkanes, phenyl alkenes, and phenyl alkynes; phenyl alkanes and phenylcyclanes; 1-phenyl and 2-phenyl compounds, and monophenyl and polyphenyl compounds. A. W.

**1115. The Influence of Structure on the Oxidation Reactivity of Hydrocarbons.** P. George and A. Robertson. *J. Inst. Petrol.*, 1946, **32**, 400–407.—The mechanism of oxidation on the basis of a chain reaction, the first isolatable product of which is a hydroperoxide, is discussed, and lines of further experiments to understand the oxidation of oils are indicated. A. H. N.

**1116. A Review of the Mechanism of the Oxidation of Liquid Hydrocarbons.** P. George and A. Robertson. *J. Inst. Petrol.*, 1946, **32**, 382–391.—In the oxidation of liquid hydrocarbons the primary intermediate is a peroxide. If a C–H bond is attacked a hydroperoxide is formed. Conjugated olefins yield ring peroxides by 1 : 4 addition of the oxygen, and also more complicated polymeric peroxides. Polycyclic aromatic hydrocarbons give transannular peroxides. After the primary formation of a hydroperoxide the course of the oxidation is governed by its decomposition. Although this is a complex reaction, there is much evidence that the ketone is the key decomposition product from which the more highly oxidised compounds are derived. Hydroperoxide formation on both the thermal and catalysed reactions proceeds by a chain mechanism. Whilst the catalyzed reactions involve free radicals as the chain carriers, there is some evidence that in the thermal reaction the chain carriers can be free radicals or energy-rich molecules, depending on the particular hydrocarbon which is oxidized. In the uncatalyzed oxidation the autocatalytic increase in the rate is due to a hydroperoxide catalyzed reaction developing side by side with the thermal oxidation. This phenomenon has been observed in many gas-phase chain reactions, and is known as degenerate chain branching. A. H. N.

**1117. Oxidation and Anti-Oxidation.** E. A. Evans. *J. Inst. Petrol.*, 1946, **32**, 392–399.—The chemistry of oxidation and dehydrogenation of several compounds and a brief study of several anti-oxidants are given. A. H. N.

**1118. Gas-Hydrate Composition and Equilibrium Data.** E. M. Frost and W. M. Deaton. *Oil Gas J.*, 27.7.46, **45** (12), 170.—The experimental techniques tried and

the procedure adopted for obtaining the composition of the hydrates formed with carbon dioxide, methane ethane, and propane at temperatures below 32° F are described. The composition of the hydrates were obtained by direct measurement of the gas and water resulting from the decomposition of the hydrates. Pressure-temperature equilibrium curves plotted from the data are shown in a graph for the gases and natural gas, and include the location of the curves plotted from the data, previously reported, for temperatures above 32° F. The hydrate compositions have also been calculated from the equilibrium data, and the mathematical analysis by which the heats of formation above and below the freezing point of water were obtained is shown.

The hydrate compositions obtained were :

| | Formula from direct Measurement | Calculated Formula |
|---|---|---|
| Methane | $CH_4 : 7\ H_2O$ | $CH_4 : 7\ H_2O$ |
| Ethane | $C_2H_6 : 8\ H_2O$ | $C_2H_6 : 8\ H_2O$ |
| Propane | — | $C_3H_8 : 18\ H_2O$ |
| Carbon dioxide | $CO_2 : 7\ H_2O$ | — |

The composition and hydrate data points of natural gas are shown in a table for the gases mentioned and for butane and higher hydrocarbon fraction. W. H. C.

## Analysis and Testing.

**1119. Theory and Application of the Parallel Plate Plastometer.** G. J. Dienes and H. F. Klemm. *J. Appl. Phys.*, June 1946, **17** (6), 458–471.—A method has been established for the measurement of the viscosity of high polymers at low rates of shear in the range $10^4$–$10^9$ poises using a parallel-plate plastometer. This is based on a mathematical criterion for separating the viscous portion of the deformation from the " elastic " and " delayed elastic " components. Experimentally, the plate separation is measured at a given temperature as a function of time. The theory furnishes a relation, which is also the criterion for predominantly viscous deformation, between viscosity, plate separation, applied load, and time. This relation, a modified form of Stefan's equation, is used for calculating the viscosity from the experimentally observed quantities. The method has been applied to polyethylene and vinyl chloride–acetate resin compounds. The viscosity–temperature behaviour of these materials is shown to be simple over the temperature range studied—that is, log viscosity varies linearly with the reciprocal of the absolute temperature. Data are presented which show that polyethylene resins and polyethylene resin–paraffin wax mixtures follow Flory's relation—*i.e.*, log viscosity varies linearly with the square root of the weight average molecular weight. Accordingly, the parallel plate plastometer offers promising possibilities for the empirical determination of the weight average molecular weight of these materials. Data are also presented on plasticized vinyl chloride–acetate resin systems which point to a close parallel between the effects of increasing temperature and increasing plasticizer concentration. A. H. N.

**1120. Viscometer for Low Viscosity Liquids.** *The Laboratory* (*Fisher Scientific Co.*), 1946, **16** (1), 8.—The newly patented Fisher–Irany viscometer gives more reliable results than are possible when working with highly mobile liquids in conventional viscosity apparatus. The outstanding feature of the instrument is that the flow of the sample is retarded to increase the time required for the sample to fall a short distance. This increase in efflux time is accomplished by a long capillary of helical shape, obviating the need for an ultra-fine capillary or a large volume of liquid, and thus retaining the normal pressure head and bore. Any error in timing the fall is therefore of minimal consequence.

Efflux times with this viscometer are about ten times those observed in a standard Ostwald pipette, and allow accurate timing of fast-flowing liquids. This is of advant-

age in determining intrinsic viscosities of high polymers in very dilute solutions, since these depend on reliable evaluation of small differences in the low-viscosity range. Errors due to the volatility of low-viscosity liquids are counteracted by the construction of the viscometer, which is such that it can be charged and then hermetically closed by a stopcock. The design also permits the use of reduced or increased pressure, as well as the use of any vapour or gas other than air in the communicating space above the surface of the liquid. The factor for the instrument is substantially the same for various liquids, whereas the Ostwald constant may deviate 7% within the same range of viscosities. C. N. T.

**1121. Viscosity Blending Chart.** W. L. Nelson. *Oil Gas J.*, 6.7.46, **45** (9), 107.—No. 100 in the *Refiner's Notebook* series gives a chart from which the viscosity of blends of oils may be estimated; with the proviso that the viscosity must be at the same temperature for both oils. An example is provided and worked out. G. A. C.

**1122. Viscosity of Coal-Fuel Oil Suspensions.** V. F. Kustov and L. L. Khotuntzev. *Petroleum*, 1946, **9**, 134–135.—See Abstract No. 1057 of 1945. K. C. G. K.

**1123. Analyses of Mixtures of Light Gases by Infra-red Absorption.** N. D. Coggeshall and E. L. Saier. *J. Appl. Phys.*, June 1946, **17** (6), 450–456.—A discussion of the application of infra-red absorption methods of analysis for light gases which do not obey Beer's law of absorption due to pressure broadening. Some of these gases do not obey Beer's law in the pure state or when contaminated by foreign gases. The method of analysis depends on the nature and intensity of the pressure broadening effect of the different components in the sample on each other. Data are presented showing the nature of some of these effects and illustrating the accuracy obtainable for certain types of analyses. The instrumentation used in routine gas analyses by infra-red in the laboratory of Gulf Research and Development Co. is described. A. H. N.

**1124. The Flash-point of Lubricating Oils for Internal Combustion Engines.** S. Sirtori. *Chimica e ind.*, 1946, **28**, 12–14.—Tests were carried out to determine the variations of flash-point of a motor oil (20·5 cs at 98·9° C) with additions of volatile diluents (gasoline, kerosine, gas oil). Both the open (Marcusson) and closed (Pensky–Marten) flash-points were determined. This latter is markedly affected by small traces of diluent; the open flash-point is less influenced. The value of flash-point as an oil characteristic is questioned; if it is retained, the open test is recommended, and low results are an indication to determine the content of the oil in excessively volatile fractions by an alternative method (*e.g.*, evaporation loss), as there is no reliable quantitative relationship between dilution and drop in flash-point. Figures are given showing the marked decrease in flash-point of I.C. engine oils after a very short period of normal use. V. B.

**1125. The Sludge Test for Transformer Oils.** C. H. Barton. *J. Inst. Petrol.*, 1946, **32**, 408–413.—The B.S.I. Sludge Test is critically studied. It is concluded that: (*a*) The results quoted in this paper demonstrate the unreliability of the B.S.I. Sludge Test and supporting the view that the reason for the unsatisfactory repeatability and reproducibility does not lie in details of technique, materials, and apparatus, but in the specified conditions of the test. (*b*) The lack of repeatability and reproducibility is sufficient to disqualify the test on a basis for specification figures, apart from the fact that the soundness of basing such specification figures on sludge alone is open to serious question. (*c*) Since, in its present form, the B.S.I. Sludge Test is unsuitable as a control on the quality of transformer oils, the test should either be abandoned or completely revised. A. H. N.

**1126. Sludging Value of Transformer Oil. Influence of Condenser Water Temperature.** P. W. L. Gossling and J. Romney. *J. Inst. Petrol.*, 1946, **32**, 424–433.—It is shown that the influence of condenser-water temperature on sludge value is such that the permissible variation in this factor in the standard method is itself sufficient to make

possible relatively large differences in sludge values obtained. It is submitted that adoption of new limits for condenser-water temperature suggested would result in a considerable improvement in precision. The condenser-water temperature also influences the acidity development during the test. A. H. N.

**1127. Oxidation Tests for Transformer Oil.** A. A. Pollitt. *J. Inst. Petrol.*, 1946, **32**, 414–423.—The American, British, and chief European procedures for carrying out oxidation tests on mineral insulating oils are described and criticized. A. H. N.

**1128. Engine Testing of Fuels and Lubricants. 2. Diesel Fuels.** P. H. Moore. *Petroleum*, 1946, **9**, 130–132.—The ignition quality of a diesel fuel is, in addition to stability and non-corrosiveness, perhaps its most important single property.

*Ignition Delay.* Prolonged ignition delay leads to too much fuel in the combustion chamber, giving rise to knocking or rough-running conditions due to excess pressure. The high-speed diesel is more sensitive to ignition quality than the low-speed engine. Thus the development and widespread use of the high-speed diesel have directed special attention to ignition quality.

*Cetane Numbers.* Fuels with cetane numbers between 37 and 60 are stated to show little difference in the amount of exhaust smoke generated, fuel consumption, or power output.

Very high ignition-quality fuels have certain drawbacks due to slowness of burning. This is shown by synthetic fuels with very long paraffinic chains and cetane numbers of 100 or more. Griep and Goddin point out that to take advantage of such fuels the compression ratio must be lowered and the engine supercharged to bring maximum pressures back to normal. It is stated that a 20% increase in output can be obtained thereby, using, for instance, a 75-cetane fuel.

*Other Fuel Characteristics.* Another fuel characteristic influencing engine operations is volatility (the higher the volatility, the lower combustion chamber deposits and exhaust smoke). Low viscosity and specific gravity also minimize deposit formation.

The two reference fuels used to determine the ignition qualities of diesel fuels are mesitylene, for poor fuels, and cetene (1-hexadecene), for good ones. These two compounds are blended for test purposes, cetene having a defined number of 100 and mesitylene one of 0. Mesitylene has been replaced by α-methylnaphthalene and cetene by cetane (*n*-hexadecane). The relationship between cetene number and cetane number has been established as cetane number = cetene number × 0·875.

*Determination of Ignition Characteristics.* Many types of engines and methods have been developed. One measures the ignition delay angle of the engine in terms of degrees of crank-angle between injection of fuel and combustion. Another uses a variable-compression engine and lowers the compression ratio until misfiring occurs. In that case both reference and sample fuels should, when matched, misfire at the same compression ratio.

A further method is to throttle the air intake until misfiring occurs. When ignition failure takes place, the vacuum at the suction to the engine is recorded. Then a reference fuel is blended to match the sample.

*Cetane Tests Compared—Laboratory Tests.* There is a tendency for various makes of diesel engines to give slightly different cetane numbers. Many physical and chemical tests have been developed to examine ignition quality. Most fall into line with engine results at times, but it is usually necessary to carry out the final determinations on an engine. When using laboratory tests, care must be exercised when examining additive-containing fuels.

*Ignition Characteristics.* Paraffinic-base distillates generally give the best ignition characteristics, followed by naphthenics, while the aromatic type is least suitable. Olefinic hydrocarbons give fairly high rating, and are superior to the naphthenic and aromatic types.

The influence of chemical structure on cetane number has been dealt with in several publications. By adding paraffinic side-chains to aromatic nuclei the cetane number is increased up to a certain limit. Generally, the more hydrogen atoms present in a molecule, the better its ignition qualities. The ideal molecular shape for the molecule of a diesel fuel is the opposite of the compact, rigid-looking molecule giving good anti-knock properties in the petrol engine.

To improve quality, solvent refining, hydrogenation, or blending with better-grade material may be employed.

*Ignition Accelerators.* A great number of such compounds are known. The alkyl nitrates are perhaps the most important, particularly amyl nitrate. Acetone peroxide is, however, claimed to be the most effective accelerator.

Most ignition accelerators are blended with the fuel, although in some cases they are added to the intake air. These ignition promoters seldom improve starting characteristics and usually lower the flash point.

*Startability Improvers.* By direct injection of diethyl ether into the cylinder during cranking, a diesel engine may be started at −40° F, whereas trouble commences at about 20° F with normal high-cetane fuel. K. C. G. K.

## Gas.

**1129. Gasoline from Natural Gas.** P. C. Keith. *Oil Gas J.*, 15.6.46, **45** (6), 102.—The Hydrocol process for conversion of natural gas into gasoline is described.

A plant, designed to process 64,000,000 cu.ft. of natural gas per day, is to be erected at Brownsville, Texas, to produce 5800 brl of motor fuel, 1200 brl of synthetic diesel oil, and 150,000 lb of crude alcohols in water solution per day. The plant will cost $15,000,000, and be in operation late in 1946. The cost of production of the gasoline is estimated at 2½ cents/gal.

The process is based on that of Fischer–Tropsch, and is a result of research into the engineering problems of this process. Natural gas is converted into a mixture of carbon monoxide and hydrogen, followed by the production of liquid hydrocarbons by catalytic reaction.

The process requires the separation of 40,000,000 cu.ft/day of high-purity oxygen from air; the recovery of 0·25 gal of natural gasoline and butane per 1000 cu.ft. of feed gas; the partial combustion of 64,000,000 cu.ft./day of natural gas with the oxygen to produce the carbon monoxide and hydrogen mixture termed Hydrocol gas; and the conversion of this into gasoline and other synthetic products. The products are separated by fractionation and absorption, and the gasoline treated to remove oxygenated compounds. It is stated that the process will ensure adequate and cheap supplies of gasoline, city gas, and petroleum products in the States for centuries, make available cheap oxygen for use in other industries, and provide raw materials for a great new synthetic chemical industry. G. A. C.

## Engine Fuels.

**1130. Modern Refining Processes. Part 6. Use of Inhibitors in Motor Gasolines.** G. Armistead. *Oil Gas J.*, 13.4.46, **44** (49), 97.—Recent studies of gasoline stability and the effect of various factors during long storage periods at tropical temperatures has greatly increased the knowledge of oxidation phenomena of gasolines, and has indicated the requirements for maximum stability of gasolines, from the aspects of gasoline oxidation and ethyl fluid decomposition.

Broadly, the conclusions arrived at may be summarized as follows: (1) Motor gasoline containing cracked constituents requires inhibiting for maximum storage stability, regardless of prior treatment; (2) All leaded gasolines under severe storage conditions require inhibiting; (3) Catalytic-cracked gasoline, which is now replacing some thermal-cracked gasoline in motor fuel, is of better stability, and thus appreciable improvement in overall base gasoline may be expected. It is, however, realized that for even the severest conditions encountered in more temperate climes there will be exceptions to the conclusions (1) and (2). The results of the tropical tests, nevertheless, forms a basis for present time specifications and practices.

The properties of gasolines most important to refiners from the viewpoint of gumming and its associated engine troubles are: (1) the amount of actual or preformed gum, the non-volatile oxidation products dissolved in the gasoline at a given time; and (2) the tendency of the gasoline to form gum under favourable conditions. The methods used in the several tests and what the results indicate are discussed. The use and mechanism of additives are discussed, and a table is given showing the maximum and minimum quantities of the inhibitors commonly used in motor gasoline—

viz., n-butyl-p-aminophenol, isobutyl-p-aminophenol, di-sec.butyl-p-phenylaminediamine, wood-tar distillate, butylaminophenol, and butylphenylenediamine, and whether they are corrosive to iron or affected by water, caustic, or air. Similar data are given for the metal inhibitor, disalicylpropylenediamine. The work carried out by the gasoline additives project of the Co-ordinating Research Council (see abstract No. 810, 1946) is discussed and the conclusions recorded. It is pointed out that the conclusions do not take into consideration the copper-dish gum or the improvement in induction period resulting from the inhibitor addition. The A.S.T.M. induction period is very high, as was necessary to meet the very severe conditions of the test, and is equivalent to approximately 580 minutes by the U.O.P. induction period test. As catalytically cracked gasoline made from silica–alumina catalyst processes have now become major components of motor gasolines in place of thermally cracked products, it is expected than an appreciable improvement in motor gasoline blends will accrue. This aspect is discussed in relation to the types of feed-stocks used; the chemical treatment employed—*i.e.*, caustic washing, sweetening, etc.—refinery economics, and the inhibitors employed. W. H. C.

**1131. Refiners Ready to Produce Aviation Safety Fuel.** F. R. Staley. *Oil Gas J.*, 15.6.46, **45** (6), 136.—Safety fuel contains no highly volatile hydrocarbons and is about as safe as kerosine. It can be manufactured by alkylation or by polymerization plus hydrogenation.

Isobutane from natural sources and refinery olefinic gas are the basis of the former process; and in the other method olefinic gases are polymerized and combined with hydrogen; the cost, however, is higher than for alkylation. It is expected that supplies will meet the needs of aviation engines produced with injection systems. G. A. C.

**1132. Antiknock Properties of Materials from Superfractionation of Natural Gasoline.** T. W. Legatski and H. R. Legatski. *Refiner*, 1946, **25** (15), 109–112.—The antiknock characteristics of narrow-boiling range fractions isolated from Mid-Continent debutanized natural gasolines by superfractionation and with concomitant sulphur removal are compared with the properties of their parent materials. Data on the nature and the properties of the hydrocarbons present in the close-cut fractions are also included. A schematic flow-sheet for a complete superfractionation and desulphurization operation potentially applicable to the treatment of natural gasoline condensates is described. An account of a representative single superfractionator unit with its auxiliary equipment is also given. G. R. N.

## Gas Oil and Fuel Oil.

**1133. Carbon Hydrogen Ratio of Catalytically Cracked Distillate Fuel Oils.** S. P. Cauley and E. B. Delgass. *Oil Gas J.*, 27.7.46, **45** (12), 166.—Studies of a procedure for estimating the minimum quality requirement of a domestic heating oil necessary for satisfactory performance are reported. It was considered that the problem would be simplified if the minimum quality could be expressed in relation to some key physical property of an oil and its distillation characteristics. For the key characteristics the carbon–hydrogen ratio was adopted as most indicative of performance. Studies to correlate the C/H ratios of pure compounds with other factors, which included the U.O.P. "K" factor, etc., were discouraging, but the correlation with diesel index showed a definite trend and, after making a boiling-point correction, a reasonable correlation was obtained.

The procedure adopted consisted of plotting the C/H ratio against an arbitrary factor "A," which is equal to the numerical value obtained when subtracting one-twentieth of the boiling point from the diesel index. A graph shows these relations plotted from the tabulated data for 24 paraffins, 25 naphthenes, 5 dicyclic, 4 olefins, and 14 aromatic, pure compounds. A nomograph based on this chart is given.

The application of this correlation for use with distillate fuel oils is described. It provides a comparison of the actual C/H ratios and those estimated by the graph, and also shows the relation of the factor "A" to the actual C/H ratio.

In the studies with catalytically cracked distillate fuels, a sample of each fuel was fractionated in a true-boiling point still and physical tests were obtained on each cut.

These data were plotted on a mid per cent basis against per cent overhead. The physical tests on nine cracked fuels are given and their evaluations are shown in graphs.

From the charts it is observed: (1) that the C/H ratios of fuels derived from intermediate type charge stocks have higher C/H ratios in the more volatile fractions than in the heavier cuts—*i.e.*, the heavier cuts are more paraffinic; (2) the C/H ratios of fuels derived from naphthenic stocks have less variation throughout the whole distillation range and tend to show a reverse trend of those from intermediate stocks. The C/H ratios estimated by this method have been used in the Socony–Vacuum combustion tests of domestic fuels and have shown good correlation with the relative performance ratings of such fuels. It can be seen from the equation for factor "A" that, if the boiling range of fuels being considered is fixed, estimated C/H values are proportional to diesel values. The lower C/H ratios of heavy fractions of catalytic stocks derived from intermediate type stocks is of interest in connection with performance in vaporizing pot-type burners. In these types of burners it is desirable to avoid excessive carbon deposits in the bottom of the burner. Seven literature references are given. W. H. C.

**1134. Average Refinery Yield of Residual to Shrink Sharply, Hulse Predicts.** *Oil Gas J.*, 15.6.46, **45** (6), 93.—A decline in yield of residual fuel from the present 26% to 10% in the next 15 to 20 years is predicted.

This is due to increased production of gasoline and distillate fuels; and importations of residual fuel oils will be necessary to meet anticipated demand. Forecasts of total petroleum demand in the United States was 5,650,000 brl daily in 1950 and 5,900,000 brl daily by 1965 compared with 3,900,000 brl daily in 1939. The demand for domestic fuel for oil-burning installations is estimated to be 350,000 brl daily in 1946, 500,000 in 1950 and 565,000 brl daily in 1965, an increase of about 65%. The demand for paraffinic fuels for diesel engines will also expand.

A downward trend in volatility, gravity, and diesel index has resulted from diversion of light distillates to gasoline manufacture. G. A. C.

## Lubricants.

**1135. Sliding Friction Under Extreme Pressures—Part 1.** S. J. Dokos. *J. Appl. Mech.*, 1946, **13**, A148–A156.—The programme of this investigation on sliding friction is concerned with the evaluation of the frictional forces which occur under very high contact pressures and under varying conditions of speed, temperature, and lubrication. The work presented herein covers the experiments which have been made on sliding friction at normal temperatures. Further experiments on boundary lubrication at normal temperatures and sliding friction at elevated temperatures will be reported in a second paper. This report indicates the behaviour of sliding friction when large normal loads react between surfaces in contact over a wide range of sliding velocities. At velocities less than 1 inch/second magnified photographs of the ruptured surfaces indicate clearly the phenomenon of stick-slip. From the experimental records obtained, it was possible to show that a functional relation exists between the following variables: (1) The sliding velocity; (2) the normal load; and (3) the frequency of stick-slip. New experimental evidence is presented indicating that the natural frequency of the apparatus involved influences the phenomenon of stick-slip.

The following conclusions are drawn: (1) For clean contact surfaces the coefficient of sliding friction greatly increases with decreasing velocity; (2) Two distinct types of sliding friction are recorded by the dynamometer at the various velocities. At velocities less than the critical velocity stick-slip friction is present, and at sliding velocities greater than the critical velocity a uniform friction record is obtained; (3) Three velocity ranges were obtained in which the coefficient of friction is decidedly influenced by the normal load. In the slowest and fastest velocity range the coefficient of friction decreases with increasing load. In the intermediate range of velocity the opposite occurs; (4) The sliding velocity stick-slip frequency curves indicate that the nature of sliding friction is influenced by the mechanical properties of the apparatus; (5) The point of intersection of the various velocity-frequency curves occurs at a certain critical velocity, beyond which stick-slip is no longer recorded. The frequency at this point is approximately equal to the natural frequency of the dynamometer and

the normal load arm; (6) The stick-slip frequency $f$, can be expressed as a simple function of the normal load $L$, and the sliding velocity $v$. This relation holds for the range of the normal load investigated; (7) The validity of the laws of Amontons and Coulomb is not apparent from the results of this investigation; (8) When high pressures exist between the surfaces, great distortion occurs beneath the surface of the metals in contact. Thus friction is not merely a surface effect, but is dependent on the bulk properties of the metals on contact; (9) At high pressures large particles of the softer metal are sheared off and adhere to the plastically deformed surface of the harder metal. A. H. N.

**1136. Secrets of German Lubricating Oil Technology Revealed. Part IV. Additives and Special Lubricants (cont.).** C. I. Kelly. *Petrol. Times*, 1946, **50**, 751.—Some details are given of the manufacture of ester-oils by the O.X.O. process: lower olefines are polymerized by aluminium trichloride and then submitted to the O.X.O. process which produces high molecular weight aldehydes for conversion into alcohols and carboxylic acids; these or the carboxylic acids plus lower alcohols give esters. The basic reaction of the O.X.O. process consists of the reacting of olefines with water gas in the presence of a Fischer–Tropsch catalyst to give aldehydes according to the general equation:

$$-CH_2-CH=CH-CH_2- + H_2 + CO \longrightarrow -CH_2-CH(CHO)-CH-CH_2-$$

The following additives and the processes for their manufacture are also reviewed: (*a*) The oxidation inhibitor R; (*b*) The corrosion inhibitor KSE; (*c*) The extreme pressure additives: (i) Mesulfol-2; (ii) J7; (iii) Etrol C.

The oxidation inhibitor "R," also known as "Z8-1" was claimed to have no effect on pour-point, bearing corrosion, wear and oiliness, and to be the most effective one examined for improving the stability of polyethylene-mineral oil mixtures.

The very good corrosion-resisting properties of KSE are found from tests which show that 3% of this additive in a lubricating oil reduces the rate of iron corrosion to 2% of the rate with the oil alone.

What is already known about the extreme pressure additive Mesulfol-2 is briefly reviewed: however, the data on this additive made available up to this date is not adequate or complete. The J7 additive for "running-in" oil (a chlorine–phosphorous dope) is reviewed in detail and its method of manufacture described. The Etrol C additive is only briefly reviewed: the information obtainable to date on this additive is also scanty. R. B. S.

**1136A. Secrets of German Lubricating Oil Technology Revealed. Part IV. Additives and Special Lubricants (concluded).** C. I. Kelly. *Petrol. Times*, 1946, **50**, 860.—The additives used by the Germans which are discussed in this section are: (*a*) Single-function additives: (i) Pour-point depressants, such as Paraflow; (ii) Viscosity index improvers, such as Paratone (Oppanol); (*b*) Multi-function additives, such as Voltol; (*c*) Other special additives: (i) Graphite; (ii) Tricresylphosphate; (iii) Chromium acetonyl acetonate.

Paraflow was manufactured mainly from the brown coal tar variety of hard paraffin wax in a chlorinated form, naphthalene, and some polystyrene by a condensation process aided by aluminium chloride. The various types of Oppanols and Voltrols and their manufacture are briefly reviewed. As well as the three special additives mentioned above, seven others are listed. R. B. S.

**1136B. Lubrication of Steam Turbines.** S. J. M. Auld and C. Lawrie. *Trans. Inst. Marine Engrs*, Aug. 1946, **58** (7).—The basic requirements of turbine oil are discussed in the light of modern turbine development, and the methods whereby these requirements are met in practice are fully described. The trends in turbine design are towards higher temperatures and speeds, with forced lubrication involving smaller quantities of oil in circulation and consequently the duty imposed on turbine oil becomes continually more severe. The authors describe the latest laboratory test methods and indicate the lines on which turbine oil specifications might be laid down. Practical consideration is given to storage and handling and to the treatment of used oil. I. W. E.

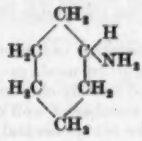
**1137. Emulsification and Demulsification. 2. Emulsifying Agents.** A. H. Stuart. *Petroleum*, 1946, **9**, 129.—Chemical and electrical demulsification processes are reviewed.

*Solid Emulsifying Agents.* The action of these is due to differential wetting, as in the "Froth-flotation" process. Silica will emulsify kerosine in water, and carbon black will produce a water in kerosine emulsion. A suitable mixture of silica and carbon black will inhibit any emulsification.

*The Use of Amines.* Triethanolamine, $N(C_2H_4OH)_3$, is one of the most valuable emulsifying agents, in combination with fatty acids, in particular oleic and stearic acids. The former is used for the emulsification of liquids, and the latter is more suitable when it is desired to emulsify waxes and highly viscous products. For the emulsification of vegetable oils moderate stirring without heat is usually sufficient, but for waxes and highly viscous materials heat is necessary (90° C is generally suitable). A method generally applicable in difficult cases of wax-emulsification is first to dissolve the wax in a suitable mineral oil, and then to emulsify the solution, as with soluble oils.

Wax emulsions are generally used to produce dry films. A type of emulsifying agent giving greater water-resistance is morpholine, $O{\cdot}(C_2H_4)_2NH$. It is used as in the case of triethanolamine, but as it is more volatile, it gradually evaporates from the wax film left by the emulsion, leaving it water resistant.

Another recently introduced amine which shows great promise is *cyclo*hexylamine :—



*Soluble Oils.* These are used for "cutting oils" with machine tools. Their function is to provide a little lubrication and a lot of cooling. The fluid is recirculated. Another use of these so-called "soluble oils" without the addition of water is as a lubricant for textile machinery. Stains on the fabric can then easily be washed out.

*Asphalts.* The Pitch Lake of Trinidad is an example of a naturally produced emulsion resulting from petroleum reaching the surface with spring water containing colloidal clay and silica, together with sodium and iron salts, etc. It is a water-in-oil emulsion containing about 29% of water.

Most asphalt and asphaltic bitumen now used in road construction is a manufactured emulsion.

Generally speaking, an oil-in-water emulsion with about 60% of oil is employed for road surfacing. K. C. G. K.

**1138. Emulsification and Demulsification.** A. H. Stuart. *Petroleum*, 1946, **9**, 163.—*Chemical Demulsification.* One of the major problems of demulsification is met with in the treatment of crude petroleum. The emulsion is stabilized in practically all cases by finely divided solid matter, such as silica or clay, whose action is oleophilic. A demulsifying agent is therefore introduced having strong adsorptive properties, which converts the oleophite particles into the oleophobic (hydrophilic) type. This starts inversion, which encourages coalescence of the water droplets. Under the action of gravity, separation then occurs. Among the substances used are: oleylhydroxystearic acid, benzene sulphostearic acid and their ammonium salts.

*The Use of Electrical Phenomena.* Some crudes form exceptionally stable emulsions, and an electrical method has been found effective, where chemical methods fail. An alternating current is used which is stepped up via a transformer to very high voltages; 5000 to 10,000 v/inch is common, but 100,000 v/inch has been employed. The emulsion is submitted to the action of this field. The globules of water represent the internal phase, being surrounded by the non-conducting oil, and acquire an induced charge, positive on one side and negative on the other. These water globules tend to form chains between the two electrodes. The small globules in any one chain coalesce, and the larger drop formed separates from the oil by gravity. Temperatures up to 180° F may be applied in some cases. K. C. G. K.

**1139. Steam Turbine Lubrication Problems and their Solutions.** A. Wolf. *Petroleum*, 1946, **9**, 136.—This is the first of an extensive series of articles, also including a study of modern inhibited oils for turbines operated by steam at moderate to high steam pressures and temperatures and for other machinery requiring lubricants of "turbine oil quality." An extensive synopsis of the main subjects to be discussed is given. At present there are no published and generally accepted specifications for turbine oils which assure satisfactory running behaviour from an oil. The trouble occurring will be due mainly to oxidation and very rapid deterioration of the oil, resulting in corrosion and deposit-formation. Such lubrication troubles are much more frequent in modern turbines operating at high pressures and temperatures than in former types. The oxidation test is therefore of prime importance with turbine oils. The present B.S.S. test is inadequate, its utility being strictly limited to the elimination of any highly naphthenic, uninhibited oils. However, some of the larger oil companies, particularly in America, have developed accelerated life tests which are a great improvement on the B.S.S. British Air Ministry or Indiana oxidation tests. The A.S.T.M. has also an oxidation test under review. It consists essentially of bubbling a slow current of oxygen through a definite volume of the oil under test and of water in a large test-tube held at 95° C in an oil or steam bath and surmounted by a water-cooled reflux condenser. A spiral of iron wire and one of copper are immersed in the oil-water mixture and serve as powerful oxidation catalysts. If required, the test may be made more severe by adding oil-soluble iron soaps (such as ferric naphthenate) to the oil.

The rate of deterioration of unstable, uninhibited turbine oils is remarkably high, considering the moderate temperature used, even without the additional oxidation catalyst. A highly solvent-refined heavily clay-treated, very pale, uninhibited turbine oil may develop a neutralization number of well over 1·0 mg KOH/g oil in as little as 50 hours. The acidity time curve is exponential, indicating auto-catalytic oxidation.

By contrast, a high-quality, well-inhibited turbine oil may take over 6000 hours to reach an acidity of 1·0 under the above conditions. K. C. G. K.

**1140. What is a Lubricant?** H. E. Mahncke. *Diesel Power and Diesel Transportation*, 1946, **24** (7), 842.—A lubricant may be defined as any substance which will reduce the friction between one object and another in contact with and in motion with respect to it. Friction is defined, and the author reviews past and present theories as to its origin and the sorts of substances which can effect its reduction, with emphasis on petroleum products. The intrinsic properties which characterize a lubricant—*i.e.*, viscosity and oiliness—are discussed separately and in detail.

C. D. B.

**1141. Lubrication Vade Mecum. Addendum (3).** E. W. Steinitz. *Petroleum*, 1946, **9**, 107.—Under section IX (continued) the following are included: air-liquefying plant, barrel cleaning and washing machines, tableting and pelleting machines, glass-bottle making and glass-blowing machines.

Section X (transportation) includes notes on the lubrication of: cableways, steam capstans, diesel, electric and steam locomotives. K. C. G. K.

**1142. Wax Mould Lubricant.** Anon. *India Rubber J.*, 1946, **111** (2), 4.—A few per cent of a recently announced wax (available in solid, granular, powdered and atomized forms) added to neoprene and synthetic rubbers gives good mould release properties, overcoming the tendency to become tacky, and facilitates production of sheets or films of vinyl or similar plastics. Improvement of hot melts of coating, impregnating, sealing, and potting compounds is effected, and the wax also imparts improved properties of moisture resistance. C. N. T.

**1143. Special Characteristics of a Self-scouring Wool Lubricant.** A. Moscowitz. *Amer. Dyestuff Reporter*, 1946, **35**, 310–311.—The latest developed product in this field combines surface activity, lubricity, and water-solubility. Earlier wool lubricants were generally oleophilic in character, and when used as an emulsion, this generally broke on the fibre, and left much to be desired in the way of penetration, stability, and uniformity of application. For cohesion of the wool fibre, the ideal lubricant

should have a high viscosity (within the range of practical application), and must not be tacky or exhibit gumming properties. The new product has a viscosity of about 400 sec (S.U.) at 100° F, exhibits the above desirable properties, and has proved effective in use, increasing the tensile strength of the yarn by about 20% in comparison with more conventional lubricants. In the presence of mild alkali, excellent coverage and normal shrinkage are obtained without the use of soap, and self-scouring is achieved by virtue of surface activity and water-solubility, even in the presence of as much as 35% of foreign oil. C. N. T.

## Bitumen, Asphalt and Tar.

**1144. Bituminous Emulsions.** Anon. *Paint Technology*, 1946, **11** (125), 197.—The film of bitumen on mineral particles obtained when a bituminous emulsion is used for preparing bituminous aggregates will tend to re-emulsify under long exposure to dampness or rain. The British patent No. 547,242 granted to the Standard Oil Development Co. states that this tendency is lessened by the use of compounds of aluminium, tin, boron, chromium, zinc, molybdenum, and vanadium, and an aliphatic amine containing more than 11 carbon atoms in a straight chain—*e.g.*, *n*-heptadecylamine. The specification describes a series of tests in which an emulsion containing 1% of the amine mentioned and 0·2% aluminium sulphate was used—(the components, amounts, and procedure of making it are given) was applied to a stone aggregate and tested for adhesion by the shaking test. Comparative tests being made with a standard emulsion. The results are given in the following table, which shows the merits of the process.

Average Time (minutes to remove 50% of the asphalt):

| Condition of Stone | Time of cure (hour) | 1 Standard emulsion | 2 1% of the amine | 3 0·2% $Al_2(SO_4)_3$ | 4 1% of the amine and 0·2% $Al_2(SO_4)_3$ | 5 2 and 3 calculated |
|---|---|---|---|---|---|---|
| Dry | 4 | 0·2 | 90 | 12·5 | 300 | 102·5 |
| " | 24 | 0·8 | 60 | 45 | 270 | 105 |
| Wet | 4 | 0·1 | 2·5 | 3·2 | 300 | 5·7 |
| " | 24 | 0·7 | 37·5 | 33·8 | 270 | 71·3 |

W. H. C.

## Special Hydrocarbon Products.

**1145. Industrial Use of Petroleum Waxes.** J. C. Dean. *Refiner*, 1946, **25** (5), 87–91.—About 80% of the production of petroleum waxes is used for the treatment of paper. Three basic types of wax-treated paper are made. The wet-waxed paper types are those which have a continuous surface film of wax, and may contain as much wax as the base paper stock. Fully refined wax is used, and to overcome its inherent brittleness up to 25% of microcrystalline wax is blended with it. The dry-waxed paper type is obtained by the controlled use of wax (either refined or scale wax), so do not possess a continuous surface film of wax. The laminated paper type employs wax as a binding as well as a moisture-proofing agent. Microcrystalline rather than ordinary paraffin wax is the most satisfactory for this purpose. Other uses for paraffin wax with particular reference to the microcrystalline type are described—*e.g.*, protective coating for liquid containers, impregnating insulating materials, blending with synthetic rubber preparations to retard " sun checking " and as a moulding wax in electrotype processes. G. R. N.

**1146. Crystallography of Waxes and Related Substances.** L. Ivanovszky and J. H. Wredden. *Petroleum*, 1946, **9**, 110.—2. The crystallography of thin wax films produced under set experimental conditions without the use of solvents is discussed. In particular, the influence of the rates of cooling and pressure on shape and growth of crystals is considered.

Microscopical examination was carried out using polarized light (crossed nicols), which gave more contrasting pictures than transmitted light or dark-ground illumina-

tion. The study of stress patterns in the photomicrographs gives additional information on the mechanism of crystal formation.

The four methods found most suitable were: (1) Slow, pressureless cooling; (2) slow cooling under slight pressure; (3) shock cooling under slight pressure; (4) shock cooling under pressure.

Striking differences in the structure of thin films of paraffin wax are illustrated and deductions made concerning the type of structures existing in different layers of wax blocks. It is well known that samples taken from different parts of slabs or larger blocks may differ in physical properties to some extent—*e.g.*, in melting point. This may be due not only to segregation currents occurring during solidification, but also as a result of different crystallographic habits and molecular re-orientations.

K. C. G. K.

**1147. Crystallography of Waxes and Related Substances. 3 (1), Photomicrographs.** L. Ivanovszky and J. H. Wredden. *Petroleum*, 1946, **9**, 143–146.—A selection of 24 photomicrographs of various types of waxes is given, the molten material being treated as discussed in Part 2 (the methods of preparing the wax films are: 1. Slow pressureless cooling; 2. Slow cooling under slight pressure; 3. Shock cooling under slight pressure; 4. Shock cooling under pressure). K. C. G. K.

## Derived Chemical Products.

**1148. Chemicals from Olefines.** H. D. Axe. *J. Soc. Dyers and Colourists*, 1946, **62** (5), 129–132.—Petroleum is now giving rise to a chemical industry similar to, but wider in scope than, that resulting from the distillation of other fuels such as wood and coal. The availability of olefines from the petroleum industry in vast quantities at very low cost has resulted in the production of synthetic chemicals such as aliphatic alcohols and their compounds, esters and ketones, plastics, synthetic resins, synthetic rubber, detergents, wetting agents, new drugs, hydrogen, and special types of carbon black.

The cracking process, intended originally for the production of lower from higher-molecular-weight hydrocarbons, initiated this development. 40 gal of fuel oil feedstock produce *ca* 1000 cu.ft. of gases, of which about 25% are olefinic, the composition being governed to a large extent by the cracking temperature. The chemical separation of the more reactive olefines gives rise directly to intermediates for chemical synthesis.

Typical products such as isopropyl alcohol, diisopropyl ether, acetone, diacetone alcohol, mesityl oxide, methyl isobutyl ketone, diisobutyl ketone, *sec.*- and *tert.*-butyl alcohols, methyl ethyl ketone, allyl alcohol, and chloride and methallyl alcohol and chloride are described, and examples of their industrial utility are quoted. At higher cracking temperatures, more unsaturated hydrocarbons (*e.g.*, butadiene) and aromatics (*e.g.*, benzene, toluene, and xylenes) can be formed from non-aromatic oils, especially in the presence of catalysts and under high pressures. Alkyl phenols, of importance in resin and disinfectant manufacture, are produced in quantity, although the yield is relatively low compared with that of other products.

High-temperature cracking of natural gas results in complete decomposition of the hydrocarbons into hydrogen and carbon. The former is, after purification, used for ammonia (and fertiliser) production; the carbon formed has a different physical character from the carbon black made by the relatively wasteful " channel " process, and is of use in rubber compounding. Because of its rather unusual properties, it is also of value to the dyestuffs industry.

Pyrolysis of the lower olefines can also give rise to low-molecular-weight aromatics in relatively high yields. Higher-molecular-weight olefines ($C_8$–$C_{20}$) are also produced, and yield products similar to those mentioned above. Typical examples are higher secondary alcohols (gum and resin solvents, and emulsion stabilizers) and sodium higher alkyl sulphates, which are polar and have extremely good surface-active properties (*e.g.*, wetting, detergent, penetrating and emulsifying action in water). Being almost neutral, very difficult to hydrolyse and stable in acid or alkali, they are of particular value to the dyestuffs and textile industries. They give good lowering of surface tension, and do not precipitate in hard water, since the calcium and magnesium salts are water-soluble, detergent, and surface-active. C. N. T.

**1149. Chemicals from Lighter Hydrocarbons.** J. E. Bludworth. *Refiner*, 1946, **25** (5), 102–105.—A general discussion is presented of the possibilities of manufacture of chemicals from propane. A tree of chemicals from this hydrocarbon is depicted separately for the four basic methods—viz., oxidation, pyrolysis, chlorination, and nitration. Proposals to utilize excess propane in the manufacture of chemicals must be accompanied by consideration of market demand for these chemicals and the effect of the increased supply on the price. G. R. N.

**1150. Chemical Smokes and Smoke Screens.** H. A. Levy. *Chem. Ind.*, 1946, **58** (6), 980.—Types of petroleum-based smokes, smoke-generating formulations and equipment, and peacetime applications are discussed. Smoke screens are of two compositions—a dispersion of solid particles in air or dispersions of minute droplets in an atmosphere in which they are not converted into the gaseous phase. Petroleum products are used for military purposes; they are low in cost and form screens of good opacity and permanence. For white smokes, lubricating oil fractions of poor viscosity index to which 12·5% ammonium chloride has been added are vaporized, 0·5–1·7% sodium stearate being added to increase the viscosity of the oil, and thus prevent too rapid settling out of the chloride.

For camouflage purposes tinted smokes were produced by adding dyes of the anthraquinone groups, such as auramine "O" for yellow; para-nitraniline and β-naphthol for red, 1 to 3 lbs dye per gallon of composition. When pigments such as umbers and sienna instead of dyes are used, two or more separate fluids are consumed in a special smoke generator, the pigments are suspended in a volatile liquid vehicle of between 100° C and 200° C boiling point, the liquid being admitted to the generator some distance from where the oil vapour smoke fluid enters. Prior mixing yields a smoke in which the pigmented particles are smeared in oil, and a white smoke results.

For continuous generation of volumes of smoke the exhaust manifold of an internal-combustion engine is used. The composition, supplied from a storage tank, flows through an atomizing nozzle fitted into the exhaust manifold, and the smoke screen is discharged from the pipe to form a curtain 8–20 ft high. A Ford Model A standard 4-cyl engine can vaporize from 5 to 20 gal of composition per hour. A steam boiler can be used, the composition being admitted through the throat of a Venturi nozzle, where it is mixed with steam and discharged to the atmosphere. A blanket screen to shroud a square mile can be produced for $200 per hour using a car exhaust; with a steam generator the cost is $160.

Post war applications include screens to protect late maturing crops from frosts, the formation of fogs in the motion picture industry, and night visible smokes.

G. A. C.

**1151. The Solubility of DDT in Kerosines.** E. E. Fleck and H. L. Haller. *Industr. Engng. Chem*, 1946, **38**, 177–178.—The solubilities of technical and pure DDT in a number of kerosines over the range +30° to −30° C have been determined. It is indicated how the aniline point of a kerosine may be used as a general guide to its solvent power for DDT. The addition of petroleum fractions rich in alkylated naphthalenes retards the crystallization from kerosine solution held at −30° C.

A. W.

## Miscellaneous Products.

**1152. Plastics from Petroleum 2 (2). Manufacturing Methods.** W. S. Penn. *Petroleum*, 1946, **9**, 106.—*Vinyl Plastics.* The production of the following plastics is discussed: polythene, polyisobutylene (for use as a plasticizer for polythene) and polystyrene.

*Acrylate Plastics.* The acrylate and methacrylate plastics are made usually from either hydroxypropionic derivatives or from halogenopropionic derivatives. These substances are obtained from acetone, which is derived from petroleum. The best-known plastic of this type is perspex.

*Alkyds* (or glyptals). These are made by condensing polybasic acids with polybasic alcohols. The majority of the compounds used can be extracted from petroleum.

*Miscellaneous Plastics.* There are several thermosetting plastics, some of which are derived from petroleum. Most are made by condensing one compound with formaldehyde—*e.g.*, aniline, furfural, lignin, *p*-sulphonamide, etc. Silicone plastics are

made from silicone tetrachloride and various aliphatic and aromatic halides. Nylon is made by condensing adipic acid and hexamethylene diamine. Resins are also made from chlorinated diphenyl, naphthalene, cumene, etc.

*Synthetic Rubbers.* These are probably the most important of the synthetic materials derived from petroleum so far.

The most important synthetic elastomers are GR–S (approximately a 75 : 25 butadiene, styrene copolymer), neoprene (a chloroprene polymer), butyl (a 97·3 isobutylene ; isoprene copolymer), and thiokol (in principle, an ethylene disulphide, sodium polysulphide condensation product).

Various petroleum derivatives are used extensively as solvents in both the natural rubber and synthetic rubber industries. K. C. G. K.

**1153. Plastics from Petroleum 3 (1). Production.** W. S. Penn. *Petroleum*, 1946, **9**, 164–165.—The article is devoted to production processes of plastics from petroleum. The information given is summarized in a chart. The production of the following types is discussed :

1. *Protein, Urea and Melamine—Formaldehyde Plastics.* The only common raw material derived from petroleum is formaldehyde.

2. *Cellulose Plastics.* The main cellulose plastics which may be manufactured from chemicals derived from petroleum are the acetate, aceto-propionate, aceto-butyrate, and the ethyl and benzyl ethers.

3. *Bakelite Plastics.* These contain about 50% of formaldehyde. The phenols, cresols, etc., are synthesized from benzene, toluene, and similar hydrocarbons, which, with certain exceptions, are not extracted from petroleum in great proportions. However, the output of such hydrocarbons from petroleum could be increased.

4. *Vinyl Plastics.* Petroleum products are pre-eminent in this field, particularly in the U.S.A. and Canada. A good example is P.V.C., made by polymerizing vinyl chloride.

5. *Acrylate Plastics.* Acrylates may be obtained from petroleum in several ways. Acetone may be prepared from propylene and methyl methylacrylate from acetone. The acrylates and methacrylates may also be produced via ethylene.

6. *Alkyds.* These are made by condensing polybasic acids and polyhydric alcohols. Phthalic anhydride, glycerol, and ethylene glycol are the commonest starting materials, although there are many others, most of which may be obtained from petroleum. Ethylene glycol is readily made from ethylene, and phthalic anhydride from naphthalene, which in turn is obtained from petroleum. Glycerol, too, is now made on a large scale from propylene and isobutene. K. C. G. K.

**1154. Ultrasonic Naftalan Emulsion.** M. M. Nevyadomskii (from *Nauka i Zhizn'*, 1945, No. 4, 22). *Petroleum*, 1946, **9**, 154.—Oil emulsions were first made using ultrasonics by Wood and Bayleigh in 1927. Ultrasonic emulsions of oil for medical purposes were introduced by the author in 1935.

In the course of a study of the chemotherapy of cancer the author discovered the tumour-destroying action of Naftalan petroleum (on test-animals) in 1930. A 68% successful cure in mice was achieved by direct introduction of Naftalan gas-oil into the nodules.

An obstacle in the way of applying the method to human subjects was that the oil, when introduced into the blood, would rapidly cause blockage of the blood-vessels and death, as had been shown in tests with animals.

To overcome these disadvantages, the oil has to be introduced in such fine form that the dimensions of the oil particles would not exceed those of the erythrocytes, having a diameter of 6–12 micron. Using ultrasonics it is possible to obtain an ideal disintegration of the oil down to a droplet size of 0·5 micron and less. This is achieved by the vibration of a metal rod at a rate more than 1,000,000 times per second (with magneto-striction equipment) or of a quartz plate (in the case of apparatus operated by a piezo-quartz crystal). At the same time, the emulsion formed is extremely stable. Such emulsions after storage for 1 to 3 years show almost no change in the size of the oil droplets. They are completely non-toxic. Experiments on 1000 animals have shown that a 12% gas-oil emulsion injection gives up to 90% cures of tumours.

During 5 years work at the Moscow polyclinic more than 15,000 injections of such emulsions have been given with favourable preliminary results. K. C. G. K.

**1155. Surface Active Compounds.** H. H. Mosher. *Amer. Dyestuff Reporter*, 1946, **35** (7), 168–173.—A general review is given of the properties and mechanism of operation of surface-active compounds, together with a description of their utility in textile operations. Typical examples of their use as: (1) luboil emulsifiers for correcting yarn dryness; (2) detergents; (3) anionic dyeing auxiliaries; (4) wetting, penetrating, dispersing, deflocculating, dye-retarding, softening, or finishing agents are quoted. Some surface active compounds are antiseptic and moth-proofing, whilst others may be developed into useful dye mordants, durable textile finishes, water-proofing, and fire-retarding agents. C. N. T.

**1156. Why Lead is Scarce.** Anon. *Chem. Ind.*, 1946, **58** (6), 978.—The principal reasons for the short supply of lead in the United States are discussed.

Labour troubles at the mines and smelters; a low ceiling price; inadequate exploration to prove reserves during the war years; a sudden reduction of imports by about 30% from the 1945 level are factors on the supply side. Increased consumption due to the requirements of the housing programme, petroleum, and automobile industries have made inroads into stocks. For example, for the production of tetraethyl lead, it is estimated that 11,000 tons will be required for the second quarter of 1946, 37% higher than for a comparable pre-war period. Tables give stocks of primary and secondary lead, total lead supply, and world lead production and consumption. G. A. C.

**1157. The Contribution of the E.R.A. to International Research on Transformer Oils.** P. W. L. Gossling and A. C. Michie. *J. Inst. Petrol.*, 1946, **32**, 356–364.—This paper deals with the research on sludge and acidity in transformer oils, which has been carried out by the E.R.A. over a long period. A. H. N.

**1158. Petrochemistry Directs Natural Gas Conversion at Lion Oil Co. Plant.** A. L. Foster. *Oil Gas J.*, 22.6.46, **45** (7), 98.—The processes by which natural gas is converted to ammonium nitrate at the Ozark Ordnance Works, El Dorado, Ark., is described.

The plant includes sulphur-removal, gas-reforming, compression, and purification units, the ammonia synthesis plant, a unit for conversion of ammonia into nitric acid and for producing the nitrate; together with auxiliary power plants.

Sulphur is removed from the raw natural gas by reaction with zinc oxide, the oxide being regenerated by heating. Low-pressure steam, superheated to 400° C, is mixed with the purified gas, and enters the reformer containing 97,000 lb of nickel metal catalyst supported on earth material, about 22,000 cu.ft. of gas being processed for each ton of ammonia synthesized. The gas leaving the primary reformer now contains only 1·5% of methane, with 11% carbon monoxide, 11·9% dioxide, and 70–75% hydrogen. The gases are mixed with air and go to the four secondary reformers at 900° C, passed over the metal catalyst, the emerging gases now containing 9·6% carbon monoxide, 11% of the dioxide, 57% hydrogen, and 21·4% nitrogen. The gas volume has now increased to 114,000 cu.ft./ton of ammonia produced.

The gases are now passed into the carbon monoxide converter at 540° C and reacted with steam over iron oxide ($Fe_3O_4$) catalyst, to convert the monoxide into dioxide. After this the gases pass through a steam interchanger, a gas interchanger, and then a water-cooled tower, emerging at 30° C, then conveyed to the compression unit, where the gas is compressed to 225 p.s.i.g. and water-scrubbed to remove carbon dioxide. The washing water is caused to generate a portion of the electric power used by passing it through four Morris hydraulic turbines which drive a 750-kW A.C. generator. In the fourth and fifth stages of the high-pressure compressors the gas is raised to 1800 p.s.i.g., passed through copper ammonium formate solution to remove all monoxide and dioxide, leaving a purified gas containing 25% nitrogen and 73–74% hydrogen, which is fed to the converter, where combination takes place over a promoted iron catalyst to form ammonia, special cooling and ducting arrangements being made. The ammonia is oxidized by burning in the presence of platinum rhodium gauze at

900° C finally to produce nitric acid, which is mixed with ammonia to form the nitrate. About 500 tons of ammonia per day is produced.

It is anticipated that the demand for fertilizer will exceed supplies. G. A. C.

## Engines and Automotive Equipment.

**1159. An Analysis of the Effects of Fuel Distribution on Engine Performance.** D. B. Brooks. *Bur. Stand. J. Res. Wash.*, 1946, **36** (5), 425.—The effects on engine performance of typical cases of maldistribution of the fuel-air mixture in a single-cylinder engine have been examined. Relating engine power to fuel consumption, engine performance curves were derived analytically from an empirical equation for typical examples of poor mixture distribution.

It was shown that minimum specific fuel consumption is a good index of distribution, improvement in this variable generally being accompanied by improvement in other engine performance variables of interest.

A method which has been developed for ascertaining the attainable improvement over a given distribution is described. T. M. B. M.

**1160. The Diesel Process in the Entropy Diagram.** M. Abdu Ibrahim and K. Elser. *Sulzer Tech. Rev.*, 1946, No. 3, 12–22.—Two main difficulties are encountered in the representation of the working process in the temperature–entropy diagram. These are: (1) the modification of the physical and chemical properties of the working medium as a result of combustion; and (2) the dependence in time of the heat supplied to the gas on the combustion and on the flow of heat through the walls.

Eichelberg proposed a combustion line for the diesel process divided as follows: 30% heat effectively supplied at constant specific volume; 50% at constant pressure and 20% at constant temperature of the working gas. The article deals with the process in a more refined fashion, taking into account the successive changes in the composition of the gas and the distribution of the heat extraction through the cylinder walls over the whole working cycle. A new division of the heat supply to the combustion process in its separate parts is also proposed. The decisive factors in the problem are influenced by engine design, and consideration was limited to the working process of a 2-stroke diesel engine with direct injection and moderate mean piston speed. A practical example illustrates the comparison of the new proposals with those of Eichelberg. I. G. B.

**1161. Testing Engine Bearings.** J. Palsulich and R. W. Blair. *Aircraft Production*, 1946, **8**, 409.—In an abstract of the paper read before the S.A.E., details of the following properties and characteristics of aircraft engine bearings are given:—

1. Maximum load-carrying capacity—the test rig uses a test bearing identical with the crankpin bearing used in production engines.
2. Friction and lubrication characteristics—of highly loaded sleeve bearings investigated on a 4-bearing friction machine designed by U.S. Bureau of Standards.
3. Fatigue life—of various bearing materials and designs of splines on master-rod bearings.
4. Corrosion resistance—done on a small laboratory (TBC) machine developed by Shell Development Co.
5. Wear resistance—on wear of overlay normally used on silver and bronze bearings, due to combination of wear and corrosion.
6. Cavitation—erosion resistance. I. G. B.

**1162. The Rolls-Royce Merlin.** Anon. *Aeroplane*, 1946, **71** (1837), 162.—The article gives a table of Merlins in civil and service use, and is claimed to be the most complete and accurate yet published. The engine characteristics are described under the headings; mark number; take-off boost and b.h.p.; low-gear combat ratings, boost, b.h.p. and altitude; high-gear combat ratings, boost, b.h.p. and altitude; weight (dry); remarks (special features). I. G. B.

**1163. Athodyds for Aircraft.** Anon. *Flight*, 1946, **50**, 155.—The article discusses the characteristics and some possible applications of the "athodyd" or "ram-jet." At

high speeds of flight the dynamic pressure of air at intake obviates the need for a compressor in the conventional jet engines. The turbine, which serves only to drive the compressor, is also unnecessary. This leads to the conception of a forward-facing duct in which air is compressed in a divergent portion, fuel added and burnt in the pressurized region and ejected to produce expansion and jet reaction.

Disadvantages of the athodyd are high fuel consumption (50–100% greater than gas turbine); necessity to provide launching power and low climb performance. Unlike the rocket, it loses power with height, but gains in efficiency with higher forward speeds. At 40,000 ft and with speeds up to 900 m.p.h. the turbine jet provides greater thrust per unit frontal area than the athodyd, but beyond this speed the athodyd gives considerably more thrust. On the basis of specific fuel consumption the relatively large difference between jet and athodyd narrows at forward speeds of 1000 m.p.h. and greater.

Outside official circles, little is known of athodyd research in Great Britain, but the recent R.A.E. exhibition included a hypothetical athodyd-propelled aircraft. Another illustration depicted the Leduc proposal for an aircraft exhibited in the Paris Salon in 1938. In the U.S.A. the Johns Hopkins University and associated organizations appear to have produced evidence of the practicability of this method of propulsion. The U.S. Navy is experimenting with a 70-lb athodyd (the "Cobra") capable of delivering thrusts sufficient for speeds up to 1500 m.p.h. In Germany, interest was also shown; on the DO 217 a Saengar athodyd was mounted on the fuselage; Focke-Wulf proposed a machine with two units at the extremities of the tail plane and a Walter bi-fuel rocket in the tail of the fuselage for take-off power; Heinkel, Skoda, and Messerschmitt also made practical proposals. The flying bomb is correctly termed a "stuttering" or "pulsating" athodyd. I. G. B.

**1164. Allis-Chalmers Gas Turbine.** Anon. *Diesel Power and Diesel Transportation*, May 1946, **24** (5), 596; May 1946, **24** (6), 720.—Recognizing the need for a gas turbine test unit capable of testing high-temperature materials under full-scale service conditions, the Bureau of Ships of the U.S. Navy arranged in 1940 for Allis-Chalmers to design and construct a 3500-h.p. experimental gas turbine unit capable of operating at 1500° F, and which was subsequently installed at the U.S. Naval Engineering experimental station at Annapolis in 1944. The experimental unit was designed to supply information to guide designers of future gas turbines for operating at this temperature for industrial and marine applications. The unit has been under test at progressively increasing turbine inlet temperatures for about two years.

The fundamental problems are discussed, and service and industrial requirements reviewed.

Features of the design of this experimental unit and the reasons for the particular layout adopted are discussed in detail. For convenience of making the necessary observations and for utmost accessibility during test a parallel arrangement was used in which one turbine drives the gas generator compressor and the second the power turbine, coupled to a water-brake for power measurement. Air leaves the gas generator compressor at 45 lb gauge and is passed via a counter-flow heat exchanger, where at full load its temperature is raised by the turbine exhaust gas from 363° F to 750° F, into two horizontal combustion chambers, supplying the gas generator turbine and the power turbine separately. These two turbines are similar, having five stages and operating at 5200 r.p.m., excepting that the latter has slightly longer blades and is fitted with an air-operated internal by-pass which is opened for starting. The high-temperature turbine wheel is air cooled. The blades and discs are constructed from Timken steel alloy containing 16% chromium, 25% nickel and 6% molybdenum. The 20-stage axial flow air compressor has a full-load capacity of 40,000 cu.ft/min. at 45 lb/sq. in. gauge and an efficiency of 85%. Turbines and compressors are fitted with sleeve bearings.

The combustion chambers each have a single oil burner. Air necessary for combustion passes through a central flame tube, the remainder flowing between the flame tube and the outer wall of the chamber, thus reducing the wall temperature and avoiding the need of refractory materials. The maximum heat release is 2,500,000 B.Th.U./cu.ft/hour. No. 2 furnace oil is used as fuel. It is predicted that boiler and fuel may be used for marine applications and powdered bituminous coal for industrial installations.

The unit can be started up by motoring up to 25–35% full speed by an electric motor of less than 100 h.p. Testing procedure is outlined and instrumentation described and some test results are given. 50 hours have been run at inlet temperatures of 1350° F, and it is estimated that the overall plant efficiency at inlet temperatures of 1500° F will be about 40%. C. D. B.

**1165. "Jet Propulsion."** F. B. Halford. *J. Roy. Soc. Arts*, **1946, 94,** 576.—The author deals specifically with the possibilities of jet-propelled civil aircraft and states the broad principles of jet propulsion, of increased flight speed and its limitations and compressibility. For a hypothetical high-altitude air-liner, 4 units each developing 2550 lb thrust at 40,000 ft would be required. Cruising at 600 m.p.h. possible future characteristics would be—expansion ratio 15 : 1; compressor efficiency 85%; combustion chamber "drag" efficiency 95%; turbine efficiency 90% and specific fuel consumption 0·88 lb/hr/lb thrust. The weight would be about 6000 lb and overall diameter 60 inch. The author completes his case by indicating the lower operating costs possible with jet-propelled air liners. I. G. B.

**1166. Precision Sheet Metal Work in the Aircraft Gas Turbine.** Anon. *Aircraft Production*, **1946, 8,** 414.—A review is given of the methods of manufacture of combustion and exhaust systems by the Burnley group of Joseph Lucas, Ltd. A large proportion of sheet metal is used in the construction of combustion systems, and much of it must withstand high operating temperatures, while tolerances of many of the components are fine for this class of work.

Particularly interesting are the accounts given of the methods used for deep-drawing and resistance welding of Nimonic sheet; radiological inspection and metallographic examination of welded joints and processes in the assembly of swirl-vane units. I. G. B.

**1167. Aluminum Alloys for High-Duty Engine Bearings.** H. Y. Hunsicker and L. W. Kempf. *Diesel Power and Diesel Transportation*, July **1946, 24** (7), 856.—Experimental work conducted by the Aluminum Co. of America on aluminum bearings for engines has evolved some promising alloys, and the paper describes tests conducted on two of these—namely Al–Sn–Cu–Ni containing 6·5% tin, 1% nickel, and 1% copper, Al–Sn–Si–Cu containing 6·5% tin, 2·5% silicon, 1% copper, and 0·5% nickel, the balance in each case being made up with aluminum of commercial purity. Test results obtained on a bearing fatigue testing machine, a scuffing test machine, and Timken machine are reviewed, the performance being compared with steel-backed tin babbitt and copper lead bearings. These and subsequent service tests show a marked superiority in several respects of the aluminum alloys, particularly with regard to load capacity, embedibility, and friction under high loads. They are stated to have a high resistance to corrosive attack by organic acids and permit the use of compounded lubricating oils. Journal wear was similar to that obtained with copper-lead bearings, and greater than that of babbitt bearings. Mention is made of the need for certain design changes in adapting existing equipment to take aluminum bearings and methods of manufacture are briefly described. C. D. B.

## MISCELLANEOUS.

**1168. Dictionary of Technical Petroleum Terms.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (158), 18–19.—A further instalment of a series. Terms are given in Italian with their English, French, Spanish, and German equivalents. V. B.

**1169. Japan's Post-War Petroleum Needs Estimated at Less than Half Those of Prewar.** W. W. Burns. *Oil Gas J.*, 13.7.46, **45** (10), 70.—The Petroleum Advisory Board set-up is described; it is composed of civilians loaned from four petroleum concerns, the Asiatic, Standard-Socony, Caltex Tide Water and, in the future, one from the Union Oil Co. of California, who act solely for General MacArthur and who have only limited communication with their firms under Military censorship. Future operations of the companies will be as a joint organization, even when Japan eventually (several years

at least) is opened to foreign commercial enterprise. The relationship will be as follows: "The military will import all petroleum products for military use and will retain ownership. The contractor (the five companies) will receive and store these products and will transport the products required to maintain prescribed levels in all Army depôts and distribution points in Japan. The contractor as directed will ship to points outside Japan and to allied occupation forces." The civilian and military oil requirements will split at the tanker and in no way interfere with each other, the civilian supply being distributed by the Japanese-directed Petroleum Distributing Co-ordinating Committee, under military control, as at present. Inspections were made of 15 refineries, 8 synthetic oil plants, and 15 distributing installations and it was decided to allow the refining of 329,000 brl (the crude oils in stock) during the three last quarters of 1946. The recovered hidden military stocks are discussed, so far those found have been used for civilian consumption. No importation is allowed for this purpose. The Petroleum Advisory Group have estimated that Japan's postwar petroleum needs to be from 12,000 to 16,000 brl/day, the prewar amount being 40,000 brl/day. North and South Sakhalin production was about 12,000 brl/day. Synthetic fuel production in 1944 was 718,000 barrels, five out of 7 synthetic plants are to be altered to manufacture ammonium sulphate instead of aviation fuel. Japan's indigenous oil production will never amount to much; the reserves are estimated at only 12,000,000 barrels. For 1946 the production is estimated at 1,400,000 barrels representing about 30% of her needs. Refinery capacity is about double the indigenous production. Until normal commercial operations are resumed the Petroleum Advisory Group will function and constantly review all phases of Japan's oil economy. General MacArthur has appointed a civilian custodian who will eventually work out some method of solving foreign property ownership. W. H. C.

**1170. German Oil Industry.** B. O. Lisle. *Petroleum*, 1946, **9**, 160.—A survey of present conditions in the German oil industry. It is shown that the restoration of the industry so far carried out is inadequate to meet the minimum essential civilian requirements. K. C. G. K.

**1171. Aviation at Work.** H. David. *Oil Gas J.*, 22.6.46, **45** (7), 78.—The use of aircraft in the petroleum industry is reviewed. In addition to the transport of executive personnel the aeroplane is employed for oil exploration and mapping, in the transportation of supervisory personnel to and from the wells, and of small equipment. Survey of the intended route for a pipe line and the patrolling of existing lines are more easily accomplished by the use of the aeroplane; they are also equipped as flying laboratories to follow up ground tests on fuels and lubricants. Oil companies employ pilot salesmen in their aviation sales departments, the latter to contact field offices, airline and airport executives and aircraft manufacturers. Exploration, drilling and supply of special equipment in foreign areas where communications are poor or non-existent are facilitated by aviation. G. A. C.

# BOOKS RECEIVED.

**Review of Petroleum Geology in 1945.** F. M. Van Tuyl and W. S. Levings. Pp. 203. Golden, Colorado: Colorado School of Mines, 1946.

No. 3 of Vol. 41 of the Quarterly of the Colorado School of Mines comprises the fourth of the annual reviews of petroleum geology prepared under the sponsorship of the American Association of Petroleum Geologists. It covers important developments in its subject during 1945 and an innovation in the present issue is a section on exploration and development in fields other than in the United States. A valuable feature is the bibliography of 59 pages, the entries being arranged under subject and geographical headings.

**Anaerobic Corrosion of Iron in Soil.** R. L. Starkey and K. M. Wright. Pp. 108. New York: American Gas Association, 1946.

This report includes the results of the American Gas Association Iron Corrosion Research Project which had the specific object of studying conditions favouring

microbial corrosion in soil and of gaining information concerning the mechanism of the corrosion process in order to ascertain means of detecting corrosive locations. A bibliography of 203 references is included.

**A Survey of General and Applied Rheology.** G. W. Scott-Blair. Pp. 196 + xv. London: Pitman, 1945. 18*s*.

Starting with a historical and general introduction to rheology, consideration is then given to rheological phenomena and their measurement, the latter part of the book dealing with rheological interpretations and the evidence of psycho-physical investigations.

**Solvents.** Thos. H. Durrans. 5th edn. reprinted. Pp. 202 + xvii. London: Chapman & Hall, 1946. 17*s*. 6*d*.

In this latest edition the section dealing with petroleum hydrocarbons has been rewritten. In general form the book follows its predecessors, Part I dealing with the scientific fundamentals broadly and Part II discusses the individual solvents.

**Modern Synthetic Rubbers.** H. Barron. 2nd edn. reprinted 1945. Pp. 355 + xii. London: Chapman & Hall, 1945. 28*s*.

Part I deals with general considerations of natural rubber and synthetic rubber-like materials and the economics of synthetic elastic materials. In the second part the chemical and physical background of these materials is discussed, while Part III, which occupies half the book, is devoted to 18 chapters on the technology of synthetic elastic materials. Petroleum as a raw material for synthetic rubber is covered in 24 pages in chapter 7.

**Journal of the Iron and Steel Institute,** Vol. CLI, 1946. Pp. 775 + xiii. London: The Iron and Steel Institute, 1946.

This volume contains a paper on "Emulsions of Oil in Water as Corrosion Inhibitors," by P. Hamer, L. Powell, and E. W. Colbeck (I.C.I. Ltd., Alkali Division) which describes an investigation undertaken with the object of preventing corrosion in recirculating cooling-water systems.

**Proceedings of the A.S.T.M.** Vol. 45, 1945. Pp. 1058 + vi. Philadelphia, Pa.: American Society for Testing Materials, 1946.

This volume contains the 1945 reports of the various A.S.T.M. committees, including that of Committee D-2 on Petroleum Products and Lubricants, D-3 on Gaseous Fuels, D-9 on Electrical Insulating Materials, and D-16 on Industrial Aromatic Hydrocarbons.

**Compilacion de los Estudios oficiales Geologicos en Colombia.** Vol. 6. Pp. 504. Bogotá: National Geological Service, 1945.

A series of papers covering part of a general survey of the mineral wealth of Colombia. Two supplements are included in separate bindings: the first (pp. 33) consists of a large-scale geological map of Colombia with accompanying explanations, and the second (pp. 127) contains a complete bibliography of previously published works on the geology and geography of the country. A. C.

**Boletin de Minas y Petroleos.** No. 150. Pp. 199. Bogota: Ministry of Mines and Petroleum, 1945.

An account of official proceedings whereby granting of certain concessions for exploiting the crude oil and mineral resources of Colombia, and withdrawal of others, was made legal. A. C.

**Memoria del Ministro de Minas y Petroleos al Honorable Congreso Nacional.** Vol. I (supplement). Pp. 143. Bogota: National Press, 1946.

Report of the newly elected Minister of Mines and Petroleum on the progress of his Ministry since taking office. The report includes current production figures for petroleum, silver, and gold, and gives details of work undertaken on behalf of the Ministry by the recently commissioned National Laboratories in Bogota. A. C.

# ABSTRACTS.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# Oilfield Exploration and Exploitation.

## Geology.

**1172. A Theory on Occurrence of Salt Domes.** R. D. Shrewsbury. *Oil Wkly*, 3.6.46, **122** (1), 36.—The parent salt bed of the domes lies many thousands of feet deep. The overburden and the salt have many of the characteristics of fluids when under sufficient pressure, and salt domes appear to rise by virtue of density differences.

The salt domes of the Gulf Coast are probably but a small segment of a very large system of similar structures, most of which are now submerged and distributed throughout the area of subsidence. If domes are still rising beneath the sea in areas where there is no erosion they may be marked by humps. The most deeply buried salt will become potentially fluid first, but will be unable to flow until adjacent salt also is fluid. Only when pressure has been transmitted to the edge of the area of salt deposition will the salt break through the overlying formations. G. D. H.

**1173. Pinch-out Trap Reservoirs.** O. Wilhelm. *Oil Gas J.*, 6.4.46, **44** (48), 139.—The term pinch-out trap is reserved for those in stratigraphic intervals having zones which actually disappear. Depositional pinch-outs may have members dropping out irregularly, in contrast with truncated pinch-out traps associated with angular unconformities. Both types occur on the flanks of uplifts and in association with salt domes. Overlap pinch-out reservoirs are found in the porous conglomeratic material on regional unconformities or at the base of marine overlaps over a basement complex. G. D. H.

**1174. Fault-trap Reservoirs.** O. Wilhelm. *Oil Gas J.*, 13.4.46, **44** (49), 119.—Faults which bring an impervious bed into contact with a porous bed may give rise to oil-traps. Sometimes even fault-gouge may be sufficient to give a seal, and at times fine sand may be effective. Much depends on the pressure and on the nature of the oil.

Thrust as well as normal faults give traps if other conditions are favourable. Fault-block reservoirs lie between more or less parallel faults. G. D. H.

**1175. Aerial Photography Aids Geologist.** F. A. Melton. *Oil Wkly*, 25.3.46, **121** (4), 48.—Stereoscopic study, in spite of its limitations, is of great value in interpreting aerial photographs. It is impossible to recognize a level surface by its aid within ½–1% without the use of bench-marks. These limits depend on the quality of the lens, the nature of the ground, and the tilt of the camera axis.

The best geological interpretation requires that only the central parts of the photographs be used, and that the focal length of the lens be 10–12 in or more.

The stereoscopic model is distorted by the prints being bent, by the line of sight not being perpendicular to the prints, by imperfect lenses, and by the camera axis being grossly tilted for one photograph of the stereoscopic pair.

Where relief is low, photo-index sheets are good picture maps. They show a wealth of detail. Large structures in thick formations are clearly visible, but stereoscopic examination is not possible, and some detail is lost in printing these sheets. In country of high relief usable index sheets cannot be made because of matching difficulties. Geological interpretation is largely dependent on the ability to interpret drainage and topographic form.

In mountainous country with thick lithological units the main structural irregularities stand out clearly; scale is relatively unimportant, and drainage patterns generally show the location if not the exact nature of the structures. Structures which are small compared with the thickness of the lithological units are difficult to discover. In strata-bench lands and in the true depositional coastal plains the drainage patterns cannot be relied upon for discovering structures. Confusion may be introduced into topographic interpretation by the effects of weathering and erosion under the rigorous late Pleistocene climate of certain regions which are warmer and dryer now.

At scales of 1 : 20,000 the bedding in soft rocks may not be visible. This scale, while popular for engineering purposes, is too small for geological studies in many

regions. A scale of 1 : 8000, with the finest-grained films, would probably be of much greater value. G. D. H.

**1176. Mattoon.** H. B. Knisely. *Oil Wkly*, 15.4.46, **121** (7), 33.—The Mattoon pool of Coles County, East Central Illinois, is about 8 ml long and 1¼ ml wide. Its reserve may be 20–30 million barrels. Numerous wells have been completed for 400 brl/day or more. The producing area is defined except possibly in the north. Mattoon has five producing horizons, although only two have been proved over a wide area. The field is on an anticline, like Loudon and Salem to the south. 27 wells have been completed in the Cypress, 107 in the Rosiclare, and 39 in both. The Cypress occurs at 1775 ft, the Rosiclare at about 1925 ft, and the Devonian at 3100 ft.

The Mattoon field was discovered in 1940, but no substantial producer was completed until 1945. The first test found oil shows; two others failed, and the fourth found McClosky production. The structure was first outlined by seismic work and core drilling.

The gas cap may cover 300 acres. In the Cypress the gas/oil ratio is 350–400 cu. ft/brl, and in the Rosiclare 500–600 cu. ft/brl. G. D. H.

**1177. Wildcat Drilling in 1945.** F. H. Lahee. *Oil Gas J.*, 13.4.46, **44** (49), 64.—5613 wildcats were drilled in U.S.A. in 1945, 4399 being dry. The total footage was 23,030,266 ft. In the southern states there were 2706 wells, 2093 being dry. Their total footage was 13,452,603 ft. Of the wells drilled on technical advice 1115 were successful and 3697 were dry. 47 wells located for non-technical reasons were successful and 404 were dry. Technical recommendations were 2·2 times as successful as those drilled without such advice.

17% more exploratory wells were drilled in 1945 than in 1944.

Roughly 60% of the wildcatting was for new fields, 20% for new pools on known producing structures, and 20% was outpost drilling or long-distance extension of partly developed pools.

894 new field wildcats were drilled by major companies (158 producers); 1854 new field wildcats were drilled by minor companies and independents (165 producers); and 288 new field wildcats (28 producers) were drilled by minor companies or independents with the drilling financed by major companies.

A series of tables summarize data on wildcat drilling, giving the footage, results, and the basis for the locations. G. D. H.

**1178. 1946 Exploration May Set New High.** Anon. *Oil Wkly*, 27.5.46, **121** (13), 47.—During April 1946, 359 exploratory completions were made in U.S.A., bringing the total for the first four months to 1372, compared with 1337 for the same period of 1945. The April exploratory completions yielded 43 oil discoveries, 11 distillate discoveries, and 12 gas discoveries. There were 85 extensions. The total discoveries in the first four months of 1946 number 523.

Tables summarize the exploratory drilling results for April and for the first four months of 1946. The April discoveries are listed with brief particulars. G. D. H.

**1179. Geology of Alaska Naval Reserve.** W. T. Foran. *Oil Wkly*, 6.5.46, **121** (10), 35 (International Section).—The earliest geological work in or near the Alaska naval reserve was in 1904. A second study began in 1923. A further investigation was initiated in 1944. This investigation showed that a petroliferous area apparently of major importance exists in Naval Petroleum Reserve No. 4. The structure and stratigraphy are favourable and active seeps exist. The area is capable of development if sufficient oil is found. Later a structure with 650-ft closure was defined, and a location for Umiat 1 was selected. Aerial photography, seismic, and gravity work were carried out.

The Umiat dome is outlined by the massive Umiat (Upper Cretaceous) sandstone. Seemingly about 35,000 ft of marine Cretaceous sediments were deposited in the Barrow basin. The uppermost 12,000 ft has excellent reservoir rocks. The Cretaceous structure may overlie fault-zones in the Palæozoic basement of Devonian, Mississippian, and Triassic. The Devonian and Mississippian are petroliferous in adjacent areas to the north. The seeps of the Barrow basin are on the rim and are almost

certainly derived from the Upper Cretaceous, with which formation there are angular discordances. The seeps are related to faults. G. D. H.

**1180. Wildcat Completions Total 15 Last Year in Eastern Canada.** Anon. *Oil Wkly*, 6.5.46, **121** (10), 39 (International Section).—During 1945 15 dry wildcats were drilled in Eastern Canada. 9 were in Kent County, Ontario. The deepest was 3685 ft, and this reached granite. G. D. H.

**1181. Geology of the Guayaquil Estuary, Ecuador.** G. Sheppard. *J. Inst. Petrol.*, 1946, **32**, 492–514.—The area studied is some 70 miles from the Pacific Ocean, and consists of the relic of an ancient estuary. The formations of the region consist of (1) Recent Deposits and (2) Tertiary Formations. The Recent Deposits comprise (*a*) fluvial, etc., including shoals and manglares (mangrove swamps), and (*b*) scree accumulations. The Tertiary Formations consist of (*a*) Chongon Sandstones and Shales; (*b*) Guayaquil Group: (1) San Eduardo Limestone; (2) Guayaquil Argillites and Cherts; (3) Moreno Sandstone; (4) Tres Cerritos Breccias. Characteristics of these formations are detailed, followed by studies of the structure and associated features of the region. A. H. N.

**1182. Spring Hill 2 in Chile is Reported as Abandoned.** Anon. *Oil Wkly*, 10.6.46, **122** (2), 23.—Spring Hill 2 is reported to be structurally lower than the discovery well, and has found water in the pay. A non-commercial amount of oil was found in a shallower sand wedge. The well is reported to have been abandoned. G. D. H.

**1183. Deeper Sand is Sought in Chile's Spring Hill 2.** Anon. *Oil Wkly*, 17.6.46, **122** (3), 31.—Spring Hill 2 has found the discovery sand of the first test dry at 7419–7438 ft. It is now drilling near 8475 ft in search of a deeper sand. G. D. H.

**1184. Concession Time Limits Spur Companies Operating in Colombia to Great Activity.** Anon. *Oil Wkly*, 6.5.46, **121** (10), 47 (International Section).—Sardinata 1 and Zahino 1 are being drilled in the Middle Magdalena Valley, southwest of the production at El Centro. La Salina 1 and Pedral 1 are being drilled in the same general area.

Tests are to be drilled in the Llanos area east of the Andes. San Martin 2 is testing a 200-ft section at 6200 ft and some 14-gravity oil is being recovered. G. D. H.

**1185. New Colombia Field Likely.** Anon. *Oil Wkly*, 17.6.46, **122** (3), 30.—Valasquez 1 in the Upper Magdalena valley of Colombia has found 20 ft of saturated sand at 7254–7274 ft, and recovered 15 stands of 35-gravity oil in a drillstem test. The sand is similar to the Guadas Tertiary sand, but it may be in the Upper Cretaceous or in the transition beds at the top of the Cretaceous. G. D. H.

**1186. Venezuela's Most Ambitious Exploratory Campaign in History Well Under Way.** M. C. Cody. *Oil Gas J.*, 13.4.46, **44** (49), 74.—37 wildcat operations have been reported in Venezuela's 1946 exploratory campaign. Three are possible new field openers, and two others have found new production. 1 well has found gas, 4 are reported dry and abandoned, and 28 are being drilled at present.

1 Caico-Seco obtained 515 brl/day of 49·7-gravity oil from the Oficina formation. Its total depth is 8515 ft, and it lies 30 km north-west of the main Oficina field. It appears to be on a new trend between the Oficina–Guara–Leona trend and the Santa Ana–San Joaquin–Guarico trend. Nipa 1, 20 km north of the Oficina field, obtained 391 brl/day of 37·5-gravity oil from the Oficina formation. A third oil discovery has been made by Mene Grande, 10 km north of the main Oficina field. This was a dual zone producer. Nipa 2 is being drilled 10 km due east of Nipa 1. 10 km east of Caico 1 a small gas producer was drilled by Socony.

1 Manguito is being drilled by Barnsdall 50 km west of the Oficina field. Operations will be renewed on BG 60, which is immediately west of the Santa Barbara field, and temporarily suspended.

Atlantic is drilling 1 San Pedro 25 km southeast of the Jusepin field, 1 El Hueso 15 km west of 1 San Pedro, and 1 Tonoro 40 km farther west. FT-1 has cored oil-

sand in the La Pica formation between 4675 and 4702 ft. This well, drilled by Phillips, is 2 km south of BG 60.

Several wildcats are being drilled in Guarico, and there are some in the Barinas area of southwestern Venezuela, which has been largely neglected because of scarcity of geological information. 4 wells are being drilled in the immediate area of Lake Maracaibo.

The wildcats are listed, and maps show their locations. G. D. H.

**1187. Phillips Venezuelan's First Wildcat Unloads Oil and Gas.** Anon. *Oil Wkly*, 13.5.46, **121** (11), 72.—Phillips' wildcat on the Mata Grande concession in Monagas has run wild, flowing several hundred barrels of oil per day and probably 50 million cu. ft. of gas. The gas and oil zone is 600 ft thick and was topped at 4581 ft, the first oil sand being at 4706 ft. The saturated zones total 375 ft in thickness. G. D. H.

**1188. England Wildcat Test is Drilling Below 2200 ft.** Anon. *Oil Wkly*, 3.6.46, **122** (1), 47 (International Section).—Kirkleatham 2, south of Hartlepool, is in the Permian below 2200 ft. Kirkleatham 1 was abandoned in Carboniferous at 3736 ft, after logging traces of oil and gas. Formby 1 is to be taken below its present depth of 6382 ft.

Seismic work is in progress in the Formby area, and gravity work in Wiltshire is continuing with a view to locating buried Carboniferous structures north of the Mendip uplift. G. D. H.

**1189. New Oil Discovery in Italy.** Anon. *Oil Wkly*, 6.5.46, **121** (10), 39 (International Section).—A new oil discovery is reported to have been made in Piacenza Province, the only Italian area which has so far yielded commercial production. G. D. H.

**1190. U.S. Companies Indicate Interest in Renewing Exploration in Italy.** Anon. *Oil Wkly*, 20.5.46, **121** (12), 68.—Societa Petrolifera Italian has begun conversations regarding the continuation of pre-war prospecting for oil. The company controls about half of Italy's 100,000 brl/year output. It is hoped that the size of concession tracts will be increased. A number of oil-bearing structures were found before the war.

The most favourable oil areas are in the Emila region, which now gives 90% of the country's output, the Pescara valley, Tuscany, and Sicily. Oil was first discovered in 1860. The cumulative production is 3½ million barrels. G. D. H.

**1191. Show of Oil is Reported in Wildcat Test South of Suez.** Anon. *Oil Wkly*, 6.5.46, **121** (10), 40 (International Section).—A wildcat at Sudr, 40 ml south of Suez, has found a good oil show at 2700 ft. G. D. H.

**1192. Sinai Peninsula Field Opened by Anglo-Egyptian Company.** Anon. *Oil Wkly*, 20.5.46, **121** (12), 68.—SUDR 1, 40 ml south of Suez, has pumped 22-gravity oil at the rate of 275 brl/day in a short pumping test of a formation between 2680 and 2925 ft. Production is believed to be from the Cretaceous.

9 ml southeast of Suez 2 dry holes have been drilled, one to 5451 ft and the other to 5808 ft. G. D. H.

**1193. Exploration in Nigeria Expected to be Resumed.** Anon. *Oil Wkly*, 6.5.46, **121** (10), 40 (International Section).—Before the war there was search for oil in northern Nigeria, north of Port Harcourt. The results have not been published, but there is a great thickness of gently folded Cretaceous and Tertiary marine and shallow-water deposits which might be expected to contain some oil. G. D. H.

**1194. Philippines Oil Development.** H. F. Bain. *Oil Wkly*, 6.5.46, **121** (10), 16 (International Section).—The oldest beds known in the Philippines are Cretaceous or even Triassic in age, but there may be older rocks in Palawan. Tertiary beds, mainly Miocene, provide the bulk of the remaining outcrops. There are also lavas and intrusives. The sediments are largely terrestrial conglomerates, sandstones, tuffs, and shales. There are some coals, and limestones which are mainly reef types.

On the Tayabas lease Standard of California has drilled 5 wells without finding

production. Far Eastern Oil Development Co. found small amounts of oil in shallow horizons penetrated by modified water-drilling equipment. The testing of the large Daanbantayan structure of northern Cebu was undertaken with a modern rig. A depth of 4000 ft was reached without finding oil, the beds having thickened a great deal. A depth of 8300 ft was reached with a new rig, an untested show having been noted at 8250 ft. The war caused a cessation of operations. A test at Barili reached 2200 ft before having to be suspended.

Leasing is briefly discussed. G. D. H.

**1195. Oil in Antarctica.** F. A. Wade. *Oil Wkly*, 1.4.46, **121** (5), 4 (International Section).—Antarctica may cover 5,000,000 sq ml, and three-quarters of it have not been seen or explored. Most of the coastline has been charted, but the interior is largely unknown.

The mountains of the Palmer Peninsula appear to be a southern extension of the Andes. Overlying the basement complex are Mesozoic beds with sandstones, conglomerate, and slaty rock. There are marine Cretaceous beds, and marine Oligocene and Miocene beds. Volcanic activity seems to have been intermittent since Miocene times. Nearly flat-lying sediments are exposed along the north and west coasts of King George VI Sound. These are of Jurassic age. In the horst bordering the Ross Sea a pre-Cambrian basement complex is overlain by a thick series of Palæozoic sediments. There are Cambrian limestones and Devonian shales and sandstones. The Permo-Carboniferous Beacon formation includes sandstones and many coals. In northern Marie Byrd land and the Edward VII Peninsula are metamorphosed sediments.

It is unknown whether the central area is a lowland or plateau-like. If the former, it has an ice cover of 5000–10,000 ft, the form of the underlying land probably being determinable by seismic survey. If the area has been repeatedly invaded by the sea, source rocks may have been deposited.

Apart from the difficulties of travel and exploration in these ice-covered areas, drilling would present many problems, and possible ice-flow would have to be considered. Any exploration for oil should be on an adequate scale. G. D. H.

## Geophysics and Geochemical Prospecting.

**1196. Airborne Magnetometer Expedites Geophysical Surveys.** G. B. Nicholson. *Oil Wkly*, 3.6.46, **122** (1), 29.—Early airborne magnetometers lacked the sensitivity needed to detect the weaker anomalies, but the use of field-sensitive fluxgates has provided a more satisfactory instrument, which gives a continuous record in association with a continuous strip camera. The U.S. Geological Survey employs a detector towed behind the plane, but the Navy has used a detector in a specially designed tail extension of the plane. The plane height is determined by a radio altimeter. The use of two instruments towed at different levels, or two flights at different altitudes yield valuable data from an interpretative point of view.

Tests were made over areas of known geological structure near Boyertown, Pennsylvania, and later over probable iron ore deposits in Iron County, Michigan. Flights over oil-bearing territory have been made in Oklahoma and the Big Horn Basin.

A standard flying height of 1000 ft is suitable for many purposes, and avoids troubles due to pipe-lines, railways, etc. Horizontal spacing of traverses ranges ¼ to 3 ml. Traverses may be as much as 30 ml long, and flying speeds of 100 to 150 m.p.h. are desirable.

In eight weeks 3170 sq ml of mountainous territory was surveyed by an aerial magnetometer. About 150 times this period would have been required for an equivalent ground survey, and the cost would have been 17 times greater. The airborne magnetometer is suitable for investigations of the continental shelf. In such areas Shoran is employed for determining the plane's position. G. D. H.

**1197. Radioactivity Experiments Aim at Finding New Reserves.** Anon. *Oil Wkly*, 22.4.46, **121** (8), 50.—Investigations which have been described recently have shown that fatty acids isolated from ocean-bottom mud can be converted into straight-chain hydrocarbons by bombardment in a cyclotron. Apparently there is sufficient

radioactive material in oilfield sediments to effect this conversion in 10–100 million years.

In the cyclotron an acid with a ring structure, and occurring in Russian and Californian crudes, when bombarded yielded a mixture of cyclic hydrocarbons. The acid itself may be a product of bacterial or radioactive action on sterols. G. D. H.

**1198. Radioactivity Logging of Dolomites.** V. J. Mercier. *Oil Wkly*, 15.4.46, **121** (7), 36.—Dolomite is weakly radioactive, and cannot be distinguished from limestone by radioactivity measurements alone. In Kansas operators are faced with the problem of evaluating dolomites such as occur in the Arbuckle, Viola, and Maquoketa formations. Gamma-ray and neutron logs have been extensively used in completing new wells and in re-working old ones. A number of examples of their application are described. G. D. H.

## Drilling.

**1199. Lateral Drilling of Limestone Reservoirs.** W. P. Sterne. *Oil Wkly*, 26.8.46, **122** (13), 34.—The use of lateral, horizontal holes drilled into limestone formations to increase drainage area and production is discussed. Examples of increasing production by this method followed by acidizing are cited. The lateral drill used is composed of an outer housing, inner housing, drive-shaft, torsion limiter, deflector rotator, whipstock, and anchor, and is composed of 206 individual pieces of material. The outer housing has a maximum diameter of 6 in at the deflector window, which limits use of the tool to wells equipped with 7-in or larger casing. The lateral drilling equipment utilizes bits varying in size from 5¼ to 6¼ in, and is sufficiently rugged to permit the application of approximately 12,000 lb weight on the bit. Since tubing is generally used for rotation, it is necessary to obtain the bit weight from drill collars. Located vertically between the outer housing and the anchor is the deflector rotator, which is so constructed that the face of the whipstock can be rotated, thus permitting the drilling of four holes in sets of two holes each, without the removal of the drill-pipe from the hole. One set of holes is several feet higher than the other, and each set is 180° apart. Within the inner housing is a flexible drive-shaft, constructed of universal joints, which has a travel of 25 ft, permitting lateral drilling of a hole 25 ft long. This flexible shaft, which is protected from wall contact by jointed housing, transmits the torque from the drill-stem, which may be tubing or drill-pipe, to the bit through the curving hole. To prevent difficulty that might result from the bit hanging up, a torsion limiter is provided on the drive-shaft. This piece of equipment cuts off the flow of drilling fluid when the torque exceeds a predetermined value. Since the drilling fluid is transmitted to the bit through the universal joint flexible shaft, it is obvious that oil must be used for circulation. The tool is stoutly constructed, and when in good condition can be operated without mechanical difficulty.

A. H. N.

**1200. Drilling in California's West Newport Field.** W. E. Dunlap and A. L. Hunter. *Oil Gas J.*, 10.9.46, **45** (14), 95.—The field, type of well drilled, and completion methods used are described, and production data are presented. The geology of the field is discussed, accompanied by excellent examples of structural delineation of the strata from electrologs of different wells. The sands of the producing zones of the Lower Ashton series are typically fine to coarse in texture, predominantly rounded, well sorted, and rather loosely consolidated. The pore spaces are well intercommunicating, as evidenced by the high permeability average of 1284 md. Porosity values are also excellent, the average being slightly over 30%. The unconsolidated nature of the oil-sands plus the high vicosity of the oil act as a handicap to production where sand-control methods are not employed. In this connection the most common practice of sand control is afforded by the use of either prepack or float-pack gravel liners. A few wells have tried conventional liners, but they have not proved satisfactory.

A. H. N.

**1201. Deep Drilling in Oklahoma.** L. L. Jones, Jr. *Oil Gas J.*, 3.8.46, **45** (13), 74.—The average depth of wells drilling in Oklahoma is increasing. Depths of 10,000 to 13,000 ft are now being reached, and one company is contemplating drilling to 17,000

to 18,000 ft. The rigs are consequently becoming large and heavier. Some of the rigs used are described. A. H. N.

**1202. Underwater Drilling For Any Depth.** A. J. Tucker. *Oil Wkly*, 12.8.46, **122** (11), 60.—The ideas described in this paper are set for the purpose of avoiding expensive platform structures usually used for marine drilling. It is proposed to use a free-floating vessel on the surface of the water, using a flexible connection between ship and well-head, and drilling the hole by some electric or hydraulic motor rotation of the drilling bit. The design of equipment and development of procedure were based on a consideration of these factors: accommodation to ship motions; ship stability; ease of abandonment; ease of recapture; drilling the well; security of the well; safety of personnel; production; and hazards to navigation. These, in turn, established the conviction that there must be complete flexibility between ship and well, except in the calmest weather, and that a submerged wellhead is a necessity. The conditions expected at sea are outlined, followed by details of design to meet the design specifications set above. It is suggested that the best ship to use is one of the largest-size landing-craft, the L.S.T. A. H. N.

**1203. An Improved British Mud-Screen for Rotary Drilling.** Anon. *Petrol. Times*, 3.8.46, **50** (1279), 796.—A newly-designed mud screen for rotary drilling is described in detail. The structure is heavier than most mud screens, but not cumbersome, and there is no chance of dangerous distortion due to transit over rough ground or operation on uneven standings. The ends of the members which are on the ground are sled-ended, with ample and convenient slinging or towing lugs provided at each end. The special features designed to remove the most frequent sources of trouble are: (1) improved shaft bearings which are identical and interchangeable; (2) the use of compound rubber buffers instead of helical springs, providing mobile stability of the screening basket; (3) the elimination of whip in the screen cloth by the patented tensioning device. R. B. S.

**1204. New Power Rig.** J. E. Kastrop. *Oil Wkly*, 12.8.46, **122** (11), 47–50.—The rig was designed to simplify transportation and assembling. Some of the special features of the rig are: (1) a sectionalized derrick which is assembled horizontally on the ground and then raised intact into upright position by means of an erection gin pole; (2) the combination of the draw works and transmission into one unit; (3) an enclosed substructure into which have been built a tool-room, a supply room, a mud-mixing and storage room, the generator room, and a crew dressing and shower room. The chief components of the rig are described in some detail and the method of erecting the mast is illustrated diagrammatically. Nine oil-country trucks are required to move the rig. The drilling mast requires two trucks, one for the upper section and one for the lower section. The two mud-pumps have been mounted on skids and are handled by two trucks. One heavy truck will carry the draw-works transmission and rotary skid, while another such truck will transport the engine and compound skid. Each of the two parallel substructure sections requires a truck for moving, and the forward substructure housing the tool-room requires one truck. Smaller items, such as the shale shaker and blow-out preventers, can be added to the lesser loads to move the entire rig with nine trucks. A. H. N.

**1205. Drilling with Counterflush Continuous Coring.** C. J. Esseling. *Min. Mag.*, 1946, **75**, 145–149.—The development of the counterflush system is given in brief, followed by a discussion of its method of use and advantages. In this method the mud stream is pumped in reverse order to that normally employed—*i.e.*, it enters the well through the annulus between casing and drill pipe and comes out of the drill-pipe lifting the core and cutting continuously. Two alternative methods of counter-flush drilling may be adopted, With the first, drilling may be continued, once the conductor has been set, with a casing-string used as drill-rods, drilling down as deep as possible with them (with this method the casing string has, of course, to be flush inside). If it is necessary to proceed with a smaller-diameter hole the casing-string used as drill-rods for the first run is left in the hole as the casing; it is caught with the slips in the casing-head or landing flange, and the bore is then continued with a smaller

casing-string used as rods. When employing this method it is necessary to use a coring-bit so constructed that the next smaller size of casing-string used as drill-pipes can pass through it. The employment of casings with sufficient wall thickness and provided with special joints enables them to be used as drill-rods with coring-bits, since the coring-bits only cut away a thin ring, and the casing-pipes are, in consequence, subjected to only a small torsional strain. If it is desired to adopt the second alternative method for counterflush drilling a string of drill-pipes for coring is used, but they must naturally be flush inside, using full-hole tool-joints. The hole is started with a fish-tail bit and, dependent on the depth scheduled, an 8-, 6-, or 4-in conductor is set and cemented against the rock, after which drilling is continued with the counterflush coring system. It must be borne in mind that if the diameter of the casing set is too large to permit of drilling the hole to the full desired depth with a counterflush bit, the hole must later be reamed in order to be able to set the next size; moreover, a second smaller string of drill-pipes, with full-hole tool-joint connections, must be available for drilling deeper. Several advantages accruing from using this method are discussed. A. H. N.

**1206. Drilling Time Reduced.** G. Weber. *Oil Gas J.*, 17.8.46, **45** (15), 108.—A discussion of drilling time in the Permian Basin and the reduction shown is ascribed to the following: (1) use of longer intermediate casing strings; (2) partial substitution of clear water for drilling mud; (3) increased weight applied to bit; (4) increased efficiency of drilling crews; (5) improved drilling equipment; (6) more prompt and efficient service; (7) increased knowledge of subsurface conditions; (8) trend towards drilling slimmer holes; (9) better control of corrosion and other causes of drill-pipe failures. Each of the above items is discussed in some detail. A. H. N.

**1207. U-Shaped Drilling Barge.** Anon. *Oil Wkly*, 2.9.46, **123** (1), 40.—The barge described and illustrated consists of two hulls brought together to form a "U" or a "horseshoe." Departing from the conventional design of drilling barges by the addition of protrusions in the aft halves of the two hulls, when the two sections are brought together, offsets or blisters coincide so as to come into contact, being separated only by a small building tolerance, and for practical purposes provide a single hull. By eliminating the usual 8-ft gap between the two barges on one end, additional buoyancy is obtained on the aft section, where the heavy equipment is located and solid steel flooring is furnished for placing pumps and other equipment on space which is ordinarily wasted.

The forward end of the drilling barge is comprised of twin hulls, each 24 ft in beam, separated by an 8-ft slot or key-way. This section of hull, adopting the conventional pattern of barge design, contains two tanks for reserve mud supply, with the deck immediately above the reserve tanks being used for pipe-racks. The barge has an overall length of 140 ft and height of the hull is 12 ft. Each component hull is 24 ft in beam at its forward end, this width extending aft 78 ft, where by means of an offset and a 90° angle, width is increased to 27 ft 10 in, remaining constant for the balance of the 62 ft to the stern. The blisters on the port and the starboard hulls are on the inside bulkheads of the respective hulls, and are contingent when the two sections are brought together, excepting for a separation of 3 or 4 in, which is packed. The two hulls when positioned properly have an overall width of 56 ft.

Other details of the barge and the drilling rig used with it are given. A. H. N.

**1208. Drill Pipe Failures in the Permian Basin.** L. R. Jackson, H. M. Banta, and R. C. McMaster. *Oil Wkly*, 19.8.46, **122** (12), 47.—An investigation of the performance of drill-pipe in the Permian Basin fields revealed that the relatively short service life of the pipe was the result of the severe corrosive conditions encountered. Drilling in this particular area is unique, in that salt beds are encountered from about 1800 to 3400 ft or deeper. The salt content of the drilling fluid attacks the steel pipe, the first stage of deterioration being manifested as corrosion pits. These pits produce a notch effect and concentrate the stresses normally developed during drilling, so that fatigue cracks are developed at the base of the pits. The cyclic stresses cause further propagation of the cracks, which leads to washouts and twist-offs. Three methods are advocated to minimize these effects. The first is to use an inhibitor.

Sodium hydroxide was found completely effective in the laboratory; in the field it was uneconomical because of the large quantities required. Of the numerous inhibitors investigated, sodium chromate—a chemical already widely used to combat corrosion—appears to be the most promising, although it does not afford complete chemical protection. Small quantities of this inhibitor were found to be more effective than similar amounts of any of the other chemical additions studied. For drilling the salt section it is recommended that a sodium chromate concentration of about 3000 parts per million by weight should be maintained, with the pH of the drilling fluid being neutral or slightly on the alkaline side—a pH of 7·0 or more. After the salt section is cased off the mud-pits should be thoroughly cleaned to insure a low salt content in the fresh-water mud. The concentration of sodium chromate should be maintained at the same level as in the salt section, with a pH of 7·0 or higher.

The second method is to coat the pipe with thermal plastic on the inside; the outside is continuously rubbing against rock, and pits are more scarce than inside. The third method is to use a special drill-pipe for the salt section alone. The drill-pipe in all three methods should be maintained in tension. A. H. N.

**1209. Patents connected with Drilling.** W. T. Cardwell, assr by mesne assignments to California Research Corpn. U.S.P. 2,404,038, 16.7.46. Method of treating mud-laden drilling fluids.—A method of treating aqueous drilling mud to produce a drilling fluid which will possess desirable viscosity, wall building, and water-loss properties, by agitating with a water-insoluble cation selective material which substitutes alkali metal cations for alkaline earth and other polyvalent cations, and then separating unwanted material.

R. R. Waterman. U.S.P. 2,404,114, 16.7.46. Water-feed system for boilers.—A special system for supplying boiler feed-water at a rate equivalent to the rate at which steam is exhausted.

J. T. Hayward. U.S.P. 2,404,132, 16.7.46. Apparatus for use in logging wells.—An apparatus for measuring and recording volumes of well-drilling fluid circulating down a drill-string and up the annulus.

J. A. Maurer, assr to J. A. Maurer Inc. U.S.P. 2,404,137, 16.7.46. Method of and means for recording electrical impulses and impulse record produced thereby.—A method of producing on a film a photographic record of electrical impulses (suitable for use in electrical well logging).

R. L. Doan, assr to Phillips Petroleum Co. U.S.P. 2,404,622, 23.7.46. Well-logging apparatus.—A special type of electrode for direct attachment to the walls of a borehole.

A. O. Roberts and J. J. Wharam, assr to Ford Motor Co. U.S.P. 2,404,657, 23.7.46. Transmission.—A variable-speed transmission of the hydraulic torque converter type.

P. H. Granger. U.S.P. 2,404,876, 30.7.46. Oil-well tool.—A device for use in cementing operations.

R. A. Ward, assr by mesne assignments to R. C. Switzer and J. L. Switzer. U.S.P. 2,405,078, 30.7.46. Method and compositions for locating surface discontinuities.—A method of detecting *subsurface* flaws having *surface* openings: suitable for drill-pipe, casing, tubing, etc.

M. T. Archer, assr to The National Supply Co. U.S.P. 2,405,546, 13.8.46. Well drilling plant: a power plant for a rotary drilling rig combining means for driving rotary table, draw-works, and mud-pumps.

G. L. Loomis. U.S.P. 2,405,794, 13.8.46. Portable derrick.—A portable derrick which can be raised as a unitary structure by the use of an auxiliary mast and hoisting drum: all equipment is on a common foundation, to which the auxiliary mast and derrick are pivotally attached.

A. H. Beal. U.S.P. 2,405,937, 20.8.46. Deviation recording device.—A device for recording the deviation of a well-bore. R. B. S.

## Production.

**1210. A Factual Analysis of the Effect of Well-Spacing on Oil Recovery.** R. C. Craze and S. E. Buckley. *Oil Gas J.*, 24.8.46, **45** (16), 97.—*Paper presented before A.P.I.* The results of studies on 103 oil-pools are analysed. Correlation is obtained between yield and viscosity, yield and permeability, etc., but it is found that yield is almost independent of well-spacing. The authors discuss the desirability of the ideal in experimentation of keeping all variables constant and varying only well-spacing before a conclusion that well-spacing is of no effect on yield can be drawn. They also point out the impossibility of such an ideal experiment. Accordingly, even though the data are not precise, it is believed that the number of observations is sufficient to afford reasonable statistical support for the position that the absence of a trend with well-spacing is significant rather than accidental. Hence, the further conclusion may be justified that these field data show the ultimate oil recovery to be independent of the well-spacing. For clarification this conclusion needs elaboration and explanation. What has been shown by these data is that distance between wells is not one of the pertinent generally applicable physical factors on which oil recovery is dependent. This conclusion does not imply that a single well will adequately drain an entire structure, nor does it imply that the recovery from any field will necessarily be independent of the number and location of producing wells. The data show an absence of a direct physical dependence, and not an absence of a geometric dependence of recovery on spacing. For example, the field with 2·6 acres/well may be highly faulted or may consist of numerous zones not co-extensive. A well density of 65 acres/well in this field might have yielded materially less oil. Conversely, however, a density of 1 well to 2·6 acres in the field drilled to 63·6 acres/well would not necessarily have increased the ultimate recovery. Although distance of drainage is not a factor controlling ultimate recovery, the geometry of the reservoirs and the location of the wells with respect to such geometry are undoubtedly important. Furthermore, the effects of well location and production rate on gas and water production may also affect the ultimate oil recovery.

Hence, a more comprehensively phrased conclusion must point out that in any reservoir a sufficient number of wells must be drilled adequately to drain the reservoir under the available conditions and type of drive operative and to supply the desired total rate of production without excessive individual well rates. This minimum number of wells required is subject to determination on a sound engineering basis for each reservoir, based upon the reservoir characteristics and the type of operation. Beyond this minimum number of wells further increase of well density will not increase the ultimate oil recovery through shortening the drainage distance. It is in this sense, and this sense only, that oil recovery has been shown to be independent of the well-spacing. A. H. N.

**1211. Secondary Recovery Production Research (A Monthly Review).** R. V. Hughes. *Producers Monthly*, June 1946, **10** (8), 8.—This month's review includes notes on well-shooting practices and on progress in production research at the Pensylvania State College. Shooting practices in England are discussed with reference to the paper entitled "Some Problems Encountered during Well Shooting Operations in the Nottinghamshire Oilfields" in the March 1946 issue of the *Journal of the Institute of Petroleum* (see abstract No. 539). A recent U.S. publication on explosives is also reviewed.

The production research discussed concerns the well-known fact that the routine air-permeability determination performed on cores from oil-producing formations cannot predict in general the ability of such a formation to conduct water, even when the core is completely saturated with water. Two tests were performed to determine the clay content of some Bradford sands. The first was the method of "differential thermal analysis" which has been used for some time in the analysis of clay minerals. The process consists of determining the temperature difference by means of a differential thermocouple between a clay sample and a thermally inert substance, both of which are being heated simultaneously at a constant and equal rate. Any chemical or physical changes in the clay involving the liberation or absorption of heat such as loss of water of hydration or changes in crystalline state will create a temperature difference between the clay and the inert substance. This produces a differential

temperature *versus* temperature curve which is characteristic of the clay minerals present.

The second test method used was the X-ray spectrometer. This apparatus subjects the sample to a stream of X-rays at a continuously varying incident angle. The intensity of the refracted beam is measured simultaneously at the same angle as the incident beam with a geiger counter. The curve produced is the scanning angle versus the intensity of the refracted beam, and is characteristic of the material being tested. These tests indicated that some sands contain clay minerals which are likely to swell in contact with water, and this may explain the variable permeabilities encountered. R. B. S.

**1212. Development of Ground Water from Wells.** E. W. Bennison. *Producer's Monthly*, June 1946, **10** (8), 16.—An adequate testing programme is an essential preliminary to any ground-water development scheme: to interpret the results obtained, considerable knowledge of the various forms of ground-water flow, ground-water velocities for different formations, and the basic hydraulic laws governing the movement of water in the formations penetrated is required; these factors are discussed.

The importance of well-screens and gravel packing and the causes of corrosion and incrustation are also discussed. In well screens corrosion is generally direct chemical corrosion, selective corrosion (or dezincification), or some form of electrolytic corrosion. The main causes of corrosion are a high content of free $CO_2$, low pH value, a high content of dissolved oxygen, the presence of $H_2S$ or similar gases in the water, or the presence of iron sulphate and other less common causes. Incrustation, which is frequently confused with corrosion, is an entirely different phenomena, being primarily due to chemical deposits caused by over-pumping or differences in pressure. Incrustation destroys the efficiency of a well-screen, while corrosion destroys the screen itself. Incrustation is the deposition and collection of mineral salts on the screen and in the formation adjacent to a screen. This deposition is due to the pressure changes and consequent release of $CO_2$ which occur when the well is being pumped. Inasmuch as these changes are greatest at or near the screen, the release of $CO_2$ is greatest here, and also the deposition of mineral salts. Incrustation is of two types, hard and soft, dependent on the chemical nature of the water and whether hardness is of carbonate or non-carbonate type. About the only means of retarding incrustation discovered to date is to lessen the rate of pumping and using more wells spaced farther apart. Acid treatment and other means have been used for temporary relief, but are not entirely satisfactory. R. B. S.

**1213. Deep Well Turbine Pumps for Secondary Oil Recovery Operations.** D. R. Rankin. *Producer's Monthly*, June 1946, **10** (8), 22.—The construction and installation of various types of deep-well turbine pumps for raising water from underground sources are discussed. R. B. S.

**1214. Cycling Operations.** H. H. Kaveler. *Oil Wkly*, 2.9.46, **123** (1), 33.—The contrasting viewpoints of present-day production and that of the past are presented. The principles of energy conservation and of increased liquid yield in retrograde fields, when cycling operations are used, are briefly outlined. Finally the advantages of unit operations are discussed. There are generally two main problems involved in unit management. One is that of convincing all the owners interested in such a pool that unitization is essential and will result in maximum benefit; the second is the problem of accomplishing a fair distribution of equities in the unit operation. The basis for equity distribution varies widely as between pools and as between areas. If the methods of equity distribution upon which unit operations are based were examined, a wide variety of methods would be found to be employed. The principle generally adhered to is to distribute equities in substantial proportion to the recoverable petroleum-in-place beneath each separate tract. Sometimes this may be accomplished by basing equity distribution upon the acre-feet of net productive formation. At other times, particularly where more than one pool is involved, it is necessary to base the equity upon the recoverable hydrocarbon-in-place beneath each respective tract. A convenient means where more than one pool is involved in a field, is to compute the amount of condensate and the amount of residue gas-in-place beneath

each tract and assign, for purpose of equity calculation only, a dollar value to the condensate and to the residue gas, and base the distribution upon the equity dollar value attributable to each tract. Once unitization is accomplished, cycling becomes more easy to accomplish and more certain of success. A. H. N.

**1215. Extrapolation of Bottom-Hole Pressure Build-Up Curves by Means of Difference Tables.** J. J. Arps. *Oil Wkly*, 22.7.46, **122** (8), 26.—A general discussion of obtaining static bottom-hole pressure for a well without shutting it down too long is presented. The methods available consist, briefly, mainly of: (1) a self-recording bottom-hole pressure gauge or pressure bomb, which records bottom-hole pressures directly; 2 fluid-level observations taken with the bailer on a sand line or a float on a wire line; to be converted by means of the fluid gradient into bottom-hole pressures; (3) indirect fluid-level observations made by means of sound-waves or possibly radio waves; (4) the "Copper Tubing Method," which uses the pressure required to blow compressed air or gas through small-diameter tubing lowered into the well alongside the production tubing; (5) the top-hole pressure build-up in dry gas wells; pressures to be corrected for weight of gas column. The graphical and other methods used to derive the static bottom-hole pressure are given in some detail. Formulae are illustrated by examples which are worked out. A. H. N.

**1216. Production Packers—Their Various Applications.** P. V. McGivern. *Oil Wkly*, 5.8.46, **122** (10), 28–29.—The use of packers for isolation of water from the producing sands, pumping and flowing from separate zones simultaneously, pumping from two zones alternately from the same well, and the disposal of salt water are briefly explained. A diagram illustrates the position of the packer in the various uses. The packer, commonly called a retainer production packer, is permanently set, and is not removable except by drilling, though the tubing may be pulled as often as required for changing pumps, cups or any other necessary repairs to the well. If, after years of service, the packer should go bad, another may be set immediately above the original without its removal. The packer is constructed of cast iron, and resists corrosion to a high degree. The packing element is protected both top and bottom by lead seal rings which prevent any fluid or gas from coming in contact with the rubber and is good for years of service. These rings also prevent the rubber from "flowing" in wells of high temperatures. The procedure adopted in setting this type of packer is described.

The packer may also be used advantageously to lessen corrosion of the casing and tubing by setting the packer in the shoe-joint and filling the annulus with live oil. Entrance of water through holes in the casing may also be prevented by filling the annulus with oil and packing the tubing head, providing of course the water pressure is sufficiently high to prevent the oil from draining off into the water zone. In addition to affording an underground storage for the oil, its presence tends to lessen electrolytic action on the pipe. A. H. N.

**1217. Lacquer Control of Loose Sand.** R. S. Adams. *Oil Wkly*, 12.8.46, **122** (11), 70.—Unconsolidated sands can give trouble either by sanding-up chokes, gravel-packs, etc., or by cutting off sections of screens, control valves, etc. To avoid such trouble lacquer was pumped through a tubing into the sand, and when this set it consolidated the sand grains. In one well a lower pay was abandoned and the operator perforated the casing into a higher oil-zone. Due to excessive amounts of unconsolidated sand, all attempts to produce the well failed. Reverse circulation with water failed to remove the gritty matter. Mud was required to clean the well and hold the sand in place. However, as soon as the mud was removed, the well would be expected to make sand again. After treating the well with the sand-lacquer material it was put on production and flowed pipe-line oil. It has been producing for more than four months, and the operator has had no sand troubles. Other examples are given to show that the method allows the advantages of high porosity and permeability of unconsolidated sands to be enjoyed without the extra troubles usually encountered with loose sand formation. A. H. N.

**1218. Gas Recovery Systems.** D. Rogers, Jr. *Oil Wkly*, 19.8.46, **122** (12), 42.—*Paper presented before A.P.I.* In fields of very low gas content the recovery of gas from

the crude is an economical necessity. Such conditions exist in the Bradford field, where gas is salvaged either at low pressures or by vacuum and burnt on the lease. Gas recovery in the Bradford field is effected at the gas–oil–water separators and stock-tanks. A typical set-up is shown. Oil, gas, and water enter the separator tank from the lead line, a bleeder line being used when necessary to take the gas directly to the separator dome, and thus prevent surging. Water is syphoned from the bottom of the separator and oil gravitates to the stock-tanks. The gas-recovery line takes gas from the top of the stock-tanks and from the separator dome. Liquid seals are placed in the line connecting the separator tank to the stock-tanks and in the lines between the stock-tanks. The gas-recovery line delivers the solution gases either directly to a vacuum pump or to a vacuum gathering system. To guard against excessive pressures or vacuum being exerted on the tanks or separator, a pressure-relief device is connected to the gas-recovery line. This is a specially built liquid seal which vents to the atmosphere whenever the pressure or vacuum in the system exceeds predetermined limits. Several diagrams illustrate the system used.

A. H. N.

**1219. Helium used by Bureau of Mines to Trace Travel of Injection Gas.** Anon. *Oil Gas J.*, 10.9.46, **45** (14), 107.—A summary of the chief findings in the U.S. Bureau of Mines R.I. 3897 by E. M. Frost, Jr., on this subject is given in the paper. The success of the method depends largely on a new instrument which rapidly detects helium in natural gas in concentrations as low as 0·001%. The chief findings are: (1) The helium content of the gas produced from a well was found to vary in a cyclical manner over a period of days. The helium content of gas produced from wells changed somewhat, depending on the way the wells were handled. Invariably the helium content of the gas drawn from a well increased when a well was shut in, as though the helium was stratifying in the casing. Also, it was noted that the helium content of gas from a well was sometimes affected by changes in the operation of the well-pump; (2) the average helium content of the gas differed in one part of the field from that in another relatively near it.

A. H. N.

**1220. Unusual Pressure Conditions Solved in Oklahoma's Second Triple-Zone Completion.** E. H. Short, Jr. *Oil Gas J.*, 17.8.46, **45** (15), 87.—Three sands with different pressures were brought in by a triple completion using packers to isolate the three formations. Special casing pack-off had to be used.

A. H. N.

**1221. Well Interference and Reservoir Drainage.** J. H. Abernathy. *Oil Gas J.*, 10.9.46, **45** (14), 110.—In recent issues of the *Oil Gas J.* this subject was discussed by Barnes, and this paper is a comment on the series, giving the history of the Oklahoma City Pool in the Wilcox sand. The following conclusions are drawn: (1) when conditions of natural water-drive exist, and where withdrawals are restricted to a rate comparable to the rate at which water encroaches, wide spacing can be most effective in obtaining recovery of oil; (2) the inverse of principle 1 is also valid; if pressures are allowed to deplete, quite close spacing is necessary to obtain an efficient recovery of the oil in place; (3) if natural water-drive does not exist, very careful consideration should be given to early down-dip injection of water, since dissolved gas-drive, gas-cap drive, and the gravity drainage mechanisms are poor substitutes for encroaching water. These lesser forces can, however, be so utilized as to materially assist the natural or artificial water-drives.

Comments by others are also given.

A. H. N.

**1222. Flowing Production *vs* Pumping Production in Water-Flood Operations.** R. C. Earlougher. *Oil Wkly*, 26.8.46, **122** (13), 38.—In secondary recovery water-flood operations the operator has the choice of flowing or pumping the producing wells. The advantages and disadvantages of flowing *versus* pumping producing wells in water-flood operations are frequently discussed, although little factual information has been presented. In an effort to determine accurately the relative merits of the two producing methods, an exhaustive study has been made of three leases containing 520 acres, of which 427 acres have been subjected to secondary recovery water-flood operations. Of the 427 producing acres studied, 169 acres have been developed for pumping production, while 258 acres have been developed for flowing production.

The investigation involved detailed study of all operational data obtained from 427 contiguous areas in Township 24 North Range 17 East, Nowata County, Oklahoma. Detailed data on water input, field characteristics, and oil production are presented. Whilst the eleven conclusions listed at the end are cautious in giving preference to either method unreservedly, enough advantages have been obtained with the flowing system over the pumping method to enable it to be recommended that in future flowing should be seriously considered when planning a new water-flooding development. Several other factors—depth and permeability—are important. A. H. N.

**1223. Water Treating Equipment Used in Secondary Oil-Recovery Operations.** L. E. Douthit. *Producer's Monthly*, June 1946, **10** (8), 28.—The use of pressure filters, chlorine feeders (chlorinators), chemical solution feeders and dry chemical feeders for water-treatment operations is briefly discussed. R. B. S.

**1224. Power-pumps for Water-flooding.** J. W. Hepburn. *Producer's Monthly*, June 1946, **10** (8), 30.—The selection of the material used in construction and design of pumps for water-flooding work is reviewed. A detailed discussion of power-pump performance follows, particular emphasis being laid on efficiency, horse-power, the influence of gas or air entrained in the water, and suction conditions.

The mechanical losses in a power-pump due to friction of the moving parts is expressed by the mechanical efficiency (*Em*) which is the ratio of the theoretical horse-power (t.h.p.) output to the brake horse-power (b.h.p.) input at the pump coupling or pulley. The mechanical efficiency can be determined only by test. The loss due to stuffing-box leakage, delay in closing of the valves, leaky valves, and amount of gas or vapour carried by the water is represented by the volumetric efficiency (*Ev*). The volumetric efficiency is the ratio of the actual capacity discharged in g.p.m. to the plunger displacement in g.p.m.—*i.e.*, the ratio of hydraulic horse-power (h.h.p.) to b.h.p. The volumetric efficiency can be determined only by test. Average values of *Ev* are 97% for horizontal duplex double-acting plunger pumps and 95% for vertical triplex single-acting pumps. The total efficiency (*Et*) of the pump indicates the overall efficiency and is determined by $Et = Em \times Ev$, or by delivery in U.S. Gal/min ($Q$) + piston displacement in U.S. gal/min ($D$).

B.h.p. is the power actually transmitted to the pump by its driver. When a pump is tested the b.h.p. is measured at the pump coupling or pulley. The h.h.p. is based on the amount of liquid actually discharged by the pump. The t.h.p. is based on the plunger displacement of the pump. The following formulæ are used to calculate pump horse-powers:

$$\text{h.h.p.} = \frac{Q \times psi}{1715} \qquad \text{t.h.p.} = \frac{D \times psi}{1715} \qquad \text{b.h.p.} = \frac{\text{t.h.p.}}{Em} = \frac{\text{h.h.p.}}{Et}$$

The application of the formulæ to specific problems is simple, and is illustrated by an example.

The installation of power-pumps is then briefly discussed, followed by some piping suggestions and a discussion of suction conditions. Any failure to provide an adequate supply of liquid to the pump will result in failure of the pump cylinders to fill properly, causing noisy operation and pounding, with impact and shock loads being imposed on all parts of the pump, with possible ultimate breakage. In order for liquid to enter the cylinder or plunger-chamber of the pump, the external pressure must be sufficiently high to overcome all the resistances existing between the supply and the plunger-chamber in the pump. A factor which is often overlooked in this connection is the head (*Ha*) required to accelerate the flow of liquid in the suction line (due to the fact that the velocity of the plungers is constantly changing). This is given by:

$$Ha = \frac{C}{K} \frac{\text{Length of pipe (ft)} \times \text{Velocity of fluid (f.p.s.)} \times \text{r.p.m.}}{\text{acceleration due to gravity.}}$$

The constants $C$ and $K$ depend respectively on the type and pump and the liquid being pumped. This formula is discussed in detail and illustrated by two examples. One reference is given. R. B. S.

**1225. Horizontal Triplex Pumps.** A. R. Maier. *Producer's Monthly*, June 1946, **10** (8), 38.—The use of horizontal triplex pumps in water-flooding operations, the design and installation, and the advantages and disadvantages of these pumps are described in some detail. R. B. S.

**1226. Electrical Drives for Water-injection Systems As Used in the Bradford Oilfield.** M. W. Folsour and W. G. Taylor. *Producer's Monthly*, June 1946, **10** (8), 44.—The considerations involved in the proper choice of motors and their control equipment for the various drives in the water-injection system are explained with reference to water wells, then to water-treating plants, pipelines, and injection pumps, and finally to lightning protection of electric power circuits and equipment. R. B. S.

**1227. V-Belt Drive on Water-injection Equipment.** J. R. Ghent. *Producer's Monthly*, June 1946, **10** (8), 48.—The adaptability of V-belt drives to mechanical equipment used in water-injection operations, the precautions needed in installation, and the methods of making changes are each described. R. B. S.

**1228. Pressure Filters.** H. Kipp. *Producer's Monthly*, June 1946, **10** (8), 26.—The use of pressure filters in water-treating programmes for water-injection schemes is reviewed. R. B. S.

**1229. Pennsylvania Air-Injection Projects.** B. F. Grant and R. B. Bossler. *Oil Wkly*, 15.7.46, **122** (7), 38.—In an attempt to convert pumping into flowing wells, experiments are being carried out to repressure a field by means of air. The requirements to be satisfied to ensure success of the scheme and engineering problems to be solved in the design of flow-strings and in the high-pressure equipment are discussed. The effect of flowing the producing wells is known quantitatively on so few air-injection properties that conversion of wells to flowing on other leases should, as a first step, be confined to a few wells grouped to serve both as a pilot operation and, if results are favourable, as a nucleus for expansion. The planning, installation, and operation of these experimental groups preferably should be under engineering supervision, so as to develop the maximum amount of information as to the physical and economic comparison between flowing and pumping. The study is being made by the Bureau of Mines. A. H. N.

**1230. Salt-Water Disposal in East Texas Field.** Part 1. W. S. Morris. *Oil Gas J.*, 10.9.46, **45** (14), 72.—The brine-injection scheme described is that for the world's largest project of its kind. Conditions in the field that brought about the formation of the East Texas Salt Water Disposal Co. as a field-wide project are recorded. Set-up of the organization is presented for the benefit of operators in other fields. Manner in which the whole field pays for the return of salt water to the Woodbine sand for the maintenance of reservoir pressure is explained fully. The technical problems and engineering solutions dealing with the sub-surface disposal of salt water are presented in the light of the experience of the Salt Water Co., together with the results accomplished to date. Many references to current literature dealing with the problem of salt-water disposal are cited. A. H. N.

**1231. Engineering Factors and Operating Problems in the East Texas Field Salt-Water Disposal.** Part 2. W. S. Morris. *Oil Gas J.*, 17.8.46, **45** (15), 89.—The gathering systems for the salt-water disposal are described, together with the chemical treatment using chlorine after aeration. The chlorine is generated electrolytically using low-voltage high-amperage direct current in salt water. When electric current is passed through salt water, sodium ions are liberated at the cathode and chlorine ions at the anode. The sodium ions react with water, forming sodium hydroxide, which in turn reacts with calcium to form carbonate, which deposits on the cathode. The chlorine evolved is dissolved in the water as chlorine, or reacts to make chlorites, chlorates, or chlorides. Chlorides are formed by the reaction of chlorine with the cathodic products. There are many possible complicated reactions in the electrolysis that are not considered important in salt-water treatment. The deposits on the cathode—usually calcium carbonate—necessitate the reversal of the current through

the electrodes or it will deposit until it connects the two adjacent electrodes, with the result that the efficiency is materially impaired. By reversing the electrode the calcium carbonate reacts with chlorine, going back in solution as calcium chloride. The current is reversed at 4-hr intervals in salt water company's operations. Sedimentation is accelerated by use of alum. The chemistry of the ensuing reaction is briefly given. A. H. N.

**1232. Engineering Factors for Pressure Filters, Pits, Injection Wells, and Other Items Used in the East Texas Field Salt Water Disposal.** Part 3. W. S. Morris. *Oil Gas J.*, 24.8.46, **45** (16), 86.—The problem of corrosion in filters and pipe systems and how it was solved using asbestos cement and plastic coatings are discussed. The construction of the concrete pits and drilling of new wells are briefly described, followed by incidental instruments, meters, pumps, etc., used in the scheme. A. H. N.

**1233. Electric Power for the Oil Industry.** W. H. Stueve. *Oil Wkly*, 15.7.46, **122** (7), 44.—Although the paper discusses the use of electric power in all the major aspects of petroleum production and refining, it will be found interesting for the quantitative data given for the power requirements *vs* depth for drilling and pumping. A graph is given to guide the selection of proper horse-power rating of the equipment, and the information obtained for the energy required at various depths, in terms of kWh/brl of 1·0 specific gravity fluid, is helpful, and indicates that there is not a great deal of choice in the selection of equipment from a standpoint of overall efficiency, for the mean average curve denotes that practically all methods are approximately 37% efficient—that is, from electric energy input to fluid delivered in surface tanks. Central powers are not used for depths much in excess of 2500 ft. Individual beam pumps can be used for almost any depth, and the submerged centrifugal pump can be used for all depths, but since the centrifugal pump is essentially a low-head, large-volume pump, it is more efficient at the shallower depths. A study of some 852 shallow wells, about 600 ft deep, shows that it requires approximately the same amount of power/barrel of fluid as the other methods, when water-flooding is used and wells flow by injection pressure. In using the curves shown, when applied to individual beam-pumps, it is suggested that the horse-power rating of the motor selected be based on the data from the curve and then increased by a factor 1·3 to 1·4. Perhaps the most versatile pumping unit is the centrifugal submerged pump, since it can be used for practically all depths and volumes desired, provided the casing is large enough. In the early Oklahoma City oilfield days this submerged centrifugal pump was used to take potential readings on wells, wherein the pump and motor would be set on the bottom and pump at the rate of approximately 5000 brls/day through a lift of about 300 ft, with the conventional 100-h.p. motor. At the 300-ft off-bottom level a packer would be located and the entire production then brought to the surface by gas lifting. This enabled operators to obtain the greatest potential possible and consequent allowables.

Requirements of refineries and pipeline services are briefly discussed. A. H. N.

**1234. Baked-on Plastic Castings Prevent Corrosion.** E. H. Short, Jr. *Oil Gas J.*, 10.9.46, **45** (14), 88.—Oilfield tubular equipment and fittings are coated with thermo-setting plastic by dipping, followed with baking, in successive layers, at 300° F and a final polymerization baking at 450° F. A survey of the plastic-coated installations in a number of fields, or a discussion with the field men concerning equipment in wells, indicates that the plastic provides excellent protection against both corrosion and the deposition of paraffin. It is too early to predict the ultimate increase in the life of plastic-coated equipment as compared with uncoated equipment. However, in many cases the plastic-coated material has been in operation for months without showing signs of corrosion, whereas the uncoated equipment previously used under the same operating conditions showed severe evidence of corrosion after only a few weeks in operation. In other cases of plastic-coated material operation, where visual inspection is not possible without dismantling of equipment, the iron content of the water in contact with the plastic-coated equipment has been decreased to practically zero. For example, a 4200-ft 4-in string of plastic-coated tubing was installed in an East Texas salt-water disposal well eight months ago. Periodic tests of the salt water show that the previously high iron content of the water has been reduced to a

negligible quantity. Other operators have found that paraffin deposition is minimized with plastic coating. A typical test of this kind was recently conducted by an operator in southern Louisiana. Six joints of plastic-coated pipe were alternately spaced with regular pipe in an under-water flow-line. This test, made during the cold winter months when paraffin deposition is usually the greatest, was conducted over a period of five months. At the end of this time the test portion of the line was inspected. The plastic-coated joints were found to be completely free of paraffin. The adjacent joints of regular pipe were coated with a layer of paraffin which had decreased the inside diameter by 1 in. Other tests and advantages are described. A. H. N.

**1235. Patents Connected with Production.** J. O. Lewis, assr, by direct and mesne assignments, of one-half to E. C. Will and one-sixth to P. R. Haas. U.S.P. 2,403,987, 16.7.46. Well-flowing apparatus. A well-flowing system comprising well-head and bottom-hole equipment.

J. A. Zublin. U.S.P. 2,404,341, 16.7.46. Method of producing oil and retaining gas through deviating bores.—A method for improving the production of oil by gas-cap drive comprising drilling at least one bore deviating from a vertical well-bore below the level of the oil-producing strata and extending upwards into it, the rate of oil removal is so controlled that a liquid seal always exists therein between the oil-producing strata and the vertical well-bore.

J. N. Norton, assr to W. C. Norris Manufacturer Inc. U.S.P. 2,404,524, 23.7.46. Pumping mechanism.—A well-pumping apparatus consisting of an accumulating chamber and an elongated expansible sack. A conductor pipe, connected to the surface, alternately supplies and exhausts a pressure fluid from the sack, and thereby pumps liquid from the accumulating chamber through a tubing string to the surface.

W. L. Church. U.S.P. 2,404,692, 23.7.46. Packer anchor.—An expansible sleeve-like packer designed so that a slight upward movement of the tubing retracts the slips which hold it in place and allows the packer to be withdrawn from the well.

L. E. Brown. U.S.P. 2,404,825, 30.7.46. Well-tester.—A device for taking a bottom-hole sample of reservoir fluids.

L. Leiserson. U.S.P. 2,404,913, 30.7.46. Agent for reducing the surface tension of liquids.—A solution of an alkyl naphthalene sulphonate and a saturated aliphatic ketone.

W. T. Smith. U.S.P. 2,404,930, 30.7.46. Well-pump.—A well-pump of the hydraulic tubing type.

A. Leyer, assr to A. G. Brown, Boveri and Cie. U.S.P. 2,404,968, 30.7.46. Regulating device for pressure fluid-controlled prime movers.—Suitable for controlling hydraulic well-pumps.

R. A. Ward, assr by mesne assignments to R. C. Switzer and J. L. Switzer. U.S.P. 2,405,078, 30.7.46. Method and compositions for locating surface discontinuities. (See abstract no. 1209).

J. D. Nixon. U.S.P. 2,405,323, 6.8.46. System and apparatus for flowing wells.—A special form of gas lift in which the " pressure fluid " is admitted at two separate points of the tubing.

J. D. Nixon. U.S.P. 2,405,324, 6.8.46. System and apparatus for flowing wells.—A special form of stage gas-lift in which the reservoir fluid is periodically moved from the bottom of the well into an accumulation chamber until a quantity of reservoir fluid has been collected : this is then displaced and elevated to the surface in the normal way.

H. G. Houston and J. B. Humphrey. U.S.P. 2,405,697, 13.8.46. Oil-well sand-pump.—A sucker-rod pump equipped with means for injecting a desanding fluid through the travelling valve to various points in the barrel. R. B. S.

## Oilfield Development.

**1236. World Crude Reserves.** L. J. Logan. *Oil Wkly*, 3.6.46, **122** (1), 20 (International Section).—At the beginning of 1946 world oil reserves were estimated to be 58,911,813,000 brl. Past production is 49,329,171,000 brl. U.S.A. has reserves of

20,826,813,000 brl, or 12·2 years supply in terms of the 1945 production. The world reserves are equal to about twenty years' supply in terms of the 1945 output.

The reserves of the Middle East are estimated conservatively at 18,500,000,000 brl. These reserves have been discovered by less than 150 wildcats.

The west hemisphere possesses 51·24% of the known reserves. U.S.A. capital controls 33,232,615,000 brl, foreign holdings being 13,238,375,000 brl, of which 6,152,000,000 brl is in South America. British capital controls about 20% of the world reserves, about two-thirds being in the Middle East. U.S.S.R. holds 13·7% of the reserves.

Tables give reserves by countries, together with the ownership, and 1945 and cumulative production. G. D. H.

**1237. Deepest Production Established by Louisiana Well at 13,778 ft.** Anon. *Oil Wkly*, 15.4.46, **121** (7), 26.—The world's deepest oil production was obtained at Weeks Island, Louisiana, on 11.4.46. Production is through perforations at 13,763–13,778 ft in the Miocene. 530 brl/day of 33-gravity oil was obtained with a gas/oil ratio of 1425. This well lies 400 ft from the previous record-holder. G. D. H.

**1238. Upward Drilling Trend Maintained in April.** Anon. *Oil Wkly*, 20.5.46, **121** (12), 54.—During the four weeks ended 27.4.46, U.S.A. had 2210 completions. 1199 found oil and 199 found gas. 8575 wells were completed in the first four months of 1946, compared with 7665 in the same period of 1945. Texas, Oklahoma, Louisiana, Illinois, Kansas, and Ohio showed the greatest increase over 1945.

The April completions are summarized by states and districts, and classified according as they were productive or dry. Similar data are given for the first four months of 1946. G. D. H.

**1239. May Completions Lag but Year's Total Leads 1945.** Anon. *Oil Wkly*, 24.6.46, **122** (4), 134.—During May 2583 wells were completed in U.S.A. 1401 obtained oil and 236 gas. The completions for the first five months of 1946 total 11,173, compared with 9990 for the same period of 1945. Texas had 3338 completions in the first five months of 1946—an 11·2% rise compared with the previous year.

The well completions are summarized by States and districts for May and for the first five months of 1946. G. D. H.

**1240. Exploratory Drilling Slowed by Shortages.** Anon. *Oil Wkly*, 24.6.46, **122** (4), 129.—During May 371 exploratory tests were completed in U.S.A. 1745 were completed in the first five months of 1946, compared with 1722 in the same period of 1945. 88 wildcats were successful in May, and 383 during the first five months of 1946. 28 new oilfields were found in May, and 8 new gas-fields.

Tables summarize the completion results by States and districts for May and the first five months of 1946, and the May discoveries are listed with a brief statement of salient data. G. D. H.

**1241. Argentina's Y.P.F.** J. E. Thomas. *Oil Wkly*, 1.4.46, **121** (5), 13 (International Section).—Oil was discovered in Argentina in 1907 in a water-well at Comodoro Rivadavia. Development was slow for a number of years. Comodoro Rivadavia has given 79% of Argentina's oil.

Plaza Huincul was discovered 30 years ago, but no substantial production was obtained before 1922. Last year it gave 5300 brl/day.

The Salta area yielded 3500 brl/day in 1942, but has declined to half that rate. The area has untested structures. Mendoza is Argentina's second most important producing area.

Argentina has produced 340,000,000 brl and has reserves of 260,000,000 brl. A number of oil refineries have been built, but no trunk pipelines. Wet gas reserves of 322,264,387 cu.m and dry gas reserves of 59,622,570 cu.m have been discovered.

Tables compare the activities of Y.P.F. and of the private companies. G. D. H.

**1242. Bolivian Production.** Anon. *Oil Wkly*, 13.5.46, **121** (11), 72.—Bolivia produced 32,365 brl of crude in December 1945. G. D. H.

**1243. Ecuador's 1945 Production Shows 9% Decline.** Anon. *Oil Gas J.*, 13.4.46, **44** (49), 73.—In 1944 Ecuador produced 2,892,188 brl of crude, and in 1945 2,622,724 brl. In 1945 exports were 2,118,323 brl. During 1945 2,475,113,000 cu.ft of natural gas was processed, yielding 41,768 brl of gasoline. G. D. H.

**1244. Daily Production in Mexican Fields Gains during February.** Anon. *Oil Wkly*, 20.5.46, **121** (12), 68.—During February the Poza Rica, Naranjos, and Panuco fields gave 3,030,183 brl of oil. The January production was 2,037,724 brl. G. D. H.

**1245. 1945 Production of Europe's Big Four is Estimated at 210 Million Barrels.** Anon. *Oil Wkly*, 17.6.46, **122** (3), 31.—It is estimated that Russia produced 175,000,000 brl in 1945, Roumania 32,480,000 brl, Austria 3,850,000 brl, and Hungary 4,550,000 brl. Apparently 5000 wells with an annual yield of 35,000,000 brl per year were destroyed by the Russians as part of the scorched-earth policy.
G. D. H.

**1246. Current Activity Reported in New Polish Fields.** Anon. *Oil Wkly*, 1.4.46, **121** (5), 49 (International Section).—Polish oil production is currently about 890,280 brl/year. 10 new wells are being drilled near Cracow, in Pomerania, in the Poznan area, and in Kiezeckie. G. D. H.

**1247. Japan.** B. F. Linz. *Oil Wkly*, 6.5.46, **121** (10), 10 (International Section).—In 1924 Japan's oil reserves were estimated to be 56 million brl, with a probable maximum figure of 500 million brl. 20–25 million brl have been produced since 1924. The chief field is in the prefecture of Akita on Honshu. This yielded 1,799,310 brl in 1936. The production in Niigata prefecture in 1936 was 584,813 brl. Hokkaido (76,226 brl) and Formosa (45,440 brl) contributed towards the 1936 total of 2,546,344 brl. Each of the areas noted has a group of fields. Production is generally fairly shallow.

A map shows the location of the oil-producing areas. G. D. H.

**1248. Iranian Oil Production Averages 400,000 brl Daily.** Anon. *Oil Gas J.*, 13.4.46, **44** (49), 73.—During December 1945 the Iranian oil production was about 12,354,000 brl. The total 1945 production was 123,873,000 brl, compared with 92,919,701 brl in 1944. G. D. H.

**1249. Government Drilling Company Differ on Australian Field.** Anon. *Oil Wkly*, 3.6.46, **122** (1), 43 (International Section).—A recent Government report on the Lakes Entrace field, Victoria, states that the oil-producing formation covers 400 acres and is 16 ft thick, with an oil content of 560,000 brl, only 15% of which is recoverable. Consequently it has decided to cease work. The managing director of Austral Oil Drilling Syndicate, however, maintains that 5000 acres have been proved, and that 7,000,000 brl of oil is available. G. D. H.

## Transport and Storage.

**1250. Capacities of Spherical Tanks.** R. T. Monson. *Oil Gas J.*, 3.8.46, **45** (13), 90.—A chart is provided to determine the volumetric content of spherical tanks with an accuracy of within 1%. Two sets of scales permit the determination of total volumes of tanks whose diameters are between 2 ft and 80 ft. Examples are given and worked out. G. A. C.

**1251. Shifting Sands in Monahans Desert are Headache for Pipeliners.** Anon. *Pipe Line News*, June 1946, 10.—The difficulties encountered in laying and maintaining pipeline in the Monahans Desert of West Texas are briefly discussed. When the pipe was laid it was buried 18 in below the surface, as the law prescribes, but severe dust-storms remove sand from under-portions of the line, leaving the pipe exposed and swinging with danger of breaking from lack of support. Three remedial methods for such a situation are in general use: (1) placing stanchions under the pipe—this

method is especially satisfactory when the pipe may be continually buried and exposed by subsequent dust-storms; (2) using bulldozers to push the sand under and over the exposed areas—this method is not satisfactory when dust-storms are frequent; (3) cutting the line and reburying it. The latter method is used only on rare occasions when the amount of erosion is extremely large. The method of reducing hazards involved in periodic inspections of the line is also described. R. B. S.

**1252. Interstate Takes to the Air!** Anon. *Pipe Line News*, June 1946, 15.—A description is given of the planes used by the Interstate Oil Pipeline Co. for general transport, pipeline patrol work, and emergency location of leaks. During his patrol the pilot looks for and reports oil-stains and other evidence of leaks, washouts, excavations close to the pipelines, deposits of debris along the right-of-way, exposure of line crossing creeks and rivers, fires of any nature adjacent to the line, and any other irregularities. The course of the lines can be easily distinguished from the air. Although they have been buried for many years and ground conditions are undisturbed, there is a certain discoloration visible from above which cannot be detected from the ground, which makes it a comparatively easy matter to follow the course of the line. Oil discoloring the terrain as the result of a break, and other abnormal conditions, stand out like the proverbial sore thumb. R. B. S.

**1253. Panhandle Eastern Pipeline Co's Two Way Radio Telephone.** F. J. McElhatton. *Pipe Line News*, June 1946, 17.—The radio telephone system operated by the Panhandle Eastern Pipeline Co is described. With this system it is possible to perform the following emergency functions: (1) in the event of failure of transmission facilities superintendents, foremen, and repair crews can be promptly notified and dispatched to the point of failure; (2) operating personnel who cannot be reached by regular means of communication can be speedily warned of sudden changes in weather or flood conditions which might cause danger to property or endanger the employee's welfare; (3) production of gas from the wells can be controlled either for reduction or increase in quantity during periods of rapidly changing operating conditions, when sufficient time is not available to dispatch special crews from the central operating point, or to handle through the routine of regular operations; (4) compressor station operation can be controlled when regular means of communication are out of service. R. B. S.

**1254. Cost Behaviour in Transportation of Natural Gases.** J. E. Flanders. *Pipe Line News*, July 1946, 11.—*Paper presented at Federal Power Commission Natural Gas hearing.* A method is proposed for determining the capital and operating costs of gas-transmission lines of various sizes and lengths. The method is illustrated by evaluating these costs for two hypothetical systems, and the results, which are shown tabularly and graphically, are discussed. The following general conclusions can be drawn:—

(i) For any given length and size of transmission line, delivery cost per Mcf increases as the load factor at which the line is operated decreases;

(ii) Delivery cost per Mcf increases approximately in proportion to the length of the transmission line for any given size line;

(iii) For any given length of transmission line with given load factor, the larger the line the less the delivery cost of natural gas. R. B. S.

**1255. Patents Connected With Transport and Storage.** W. F. Aller, assr to The Sheffield Corporn. U.S.P. 2,403,897, 16.7.46. Leakage gauging device.—A gauging device for measuring fluid leakage.

A. L. Ellis, assr to Vickers Inc. U.S.P. 2,403,913, 16.7.46. Power transmission.—A control device comprising means for varying pump displacement and regulating same in response to pump-discharge pressure variations.

H. O. Parsons. U.S.P. 2,404,087, 16.7.46. Gauging and sampling device.—A gauge suitable for determining the level of liquid in a container under pressure greater than atmospheric.

W. C. Buttner and S. L. Sundstrom, assr to The Bastian Blessing Co. U.S.P. 2,405,998, 20.8.46. Liquified petroleum gas equipment.—A means for storing liquified natural gas. R. B. S.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**1256. Waste Heat Recovery in Refinery Process Equipment.** Part 12. G. Armistead, Jr. *Oil Gas J.*, 10.8.46, **45** (14), 100.—In this part of the series methods in common use for the recovery of waste heat in various types of modern processing systems are quantitatively discussed.

Recovery systems are classified as those in which heat recovered is returned directly to the system, and those wherein heat being rejected from one process system is utilized to fill the requirements of some other system. Factors conducive to high recovery rates per unit of equipment include those which favour high-temperature differential and those which permit realization of the high overall heat-transfer coefficients of the fluids involved.

Available quantities of heat and temperature differences should be balanced throughout the system.

A flow-sheet shows the heat recovery on a multi-stage crude-distillation unit, heating of crude and the required flashing temperature being conventionally accomplished.

A combustion crude and cracking unit operating at a relatively low crack per pass over-all has large amounts of waste heat to dissipate—enough to effect distillation of crude up to a considerable portion of the gas-oil range by heat exchange. Heat withdrawal is mainly effected on high-temperature vessels through a reflux condensate intermediate of the fractionators.

Difficulties are likely to arise due to fouling of the exchanger by tar from the evaporator surface on the vapour side. In transfer exchangers on thermal cracking systems the effluent from the cracking or polymerization coil is exchanged with feed to the same system, the exchangers operating at pressures up to 2000 lb. Deposition and building up of coke must be avoided by control of phase relations in the transfer-line exchange system.

In the Houdry catalytic cracking process operation is at a conversion per pass far higher than thermal cracking units and usually at lower temperature, independent of crude running facilities. The heat-recovery system is similar to that of independent thermal cracking units. The heat-absorbing medium in the catalyst cases is a molten nitrate–nitrite salt mixture at 800 to 900° F, which furnishes endothermic heat of reaction to the cases then on process, the remaining heat dissipation being effected by steam generation and superheating.

In the Fluid catalytic cracking process the two principal heat-recovery means are catalyst heat exchanger on the regenerator and absorption of heat by the feed introduced into the catalyst from the entrance to the reactor.

The Thermofor catalytic cracking heat-recovery system removes heat from the combustion of carbon in the burning zone through boiler-water exchange in a tube system. Steam is generated at 5–7 lb/hour per pound of carbon burnt. G. A. C.

**1257. Continental Oil Co. Streamlines Wichita Falls Refinery.** R. B. Tuttle. *Oil Gas J.*, 17.8.46, **45** (15), 84.—The streamlining of the Company's combination unit on overhaul is described.

The unit processes 6,000 brl/day of North Texas crude averaging about 40·7° A.P.I. gravity and containing 150 lb of salt per 1000 brl, a Petreco 3-unit installation achieving the desalting. A new electrically driven desalter pump has been installed, and a new 895 sq.ft heat exchanger unit added.

The bubble-tower was constructed from the shell of the existing one, 32 new Glitch truss-type stainless-steel trays being fitted. A bank of previously used tubular cooler-condensers is used to cool the product from the reflux receiver. 300 brl of diesel oil per day is obtained. Steam-stripped naptha enters the reforming unit at 1000 brl/day, and 550 brl of kerosine per day is produced.

No alterations were made to the vis breaking furnace or coils, but new floor tubes were fitted in the naphtha reforming furnace and coil. An evaporator operating at 75–80 p.s.i. and at about 800° F have been added, the fuel oil from the bottom being used as a quench material. G. A. C.

## Distillation.

**1258. Pipe-Still Duty.** W. L. Nelson. *Oil Gas J.*, 17.8.46, **45** (15), 117.—No. 106 in the *Refiner's Notebook* series concerns the computation of the thermal capacity of a pipe-still, referred to as its "duty," which is the heat required to raise the temperature of the material to the tower vaporizer temperature, plus the heats of vaporization and reaction of the products vaporized. An example is given and worked out based on data from previous notes in the series. G. A. C.

**1259. Pipe-Still Combustion Charts.** W. L. Nelson. *Oil Gas J.*, 24.8.46, **45** (16), 127.—No. 107 in the *Refiner's Notebook* series deals with the computation of heat balances for pipe-stills and boiler installations. Two charts are provided showing three fuels, but these may be used for normal fuels ranging from 8° to 25° A.P.I., and for any of the gas compositions common in refineries.

Two examples are given and worked out. G. A. C.

**1260. Pipe-Still Arrangements.** W. L. Nelson. *Oil Gas J.*, 24.8.46, **45** (16), 128.—No. 104 of the *Refiner's Notebook* series lists 10 types of pipe-still arrangements, including convection, radiant circular, down, centre, and overhead convection, single and double up-fired, A-frame, circular, and straight up varieties. Diagrams of each are given, with notes. G. A. C.

## Absorption and Adsorption.

**1261. South Coles Levee Unit Pressure Maintenance and Cycling Project.** L. P. Foote. *Oil Gas J.*, 3.8.46, **45** (13), 70.—An oil-absorption cycling plant is described. The South Coles Levee oilfield, in San Joaquin Valley, California has 67 completed wells, divided equally between black oil and condensate production. Study of the conditions resulted in the installation of a cycling programme for the gas-cap to prevent loss of liquid recovery, due to pressure decline in the reservoir, concurrently with a pressure maintenance scheme in the black oil area.

The plant is of the oil-absorption type with a capacity of 60,000,000 cu.ft/day of wet gas, and recovers 7000 brl/day of liquified products, 4650 brl of 50° A.P.I. condensate; and 17,000 brl of other products. Gas is transported from the fields in 3-in and 4-in pipes, at pressures of about 1800 p.s.i. at 110 to 140° F, reduced to 1500 p.s.i. and passed through cooling coils to emerge at 90° F, and thence to a high-pressure separator, liquid continuing to a fractionation system. The gas is fed to a high-pressure absorber and contacted with sufficient oil. A high-pressure residue scrubber takes the gas before it goes to the second-stage repressure compressors, after which it is cooled to 160° F and returned to the sand through five injection wells. The compressors can deliver 54,500,000 cu.ft/day of absorber gas at 4000 p.s.i. to the injection system.

Gas from black oil production arrives at the plant at three different pressures, 450, 60 p.s.i., and 6-in vacuum. The 450 p.s.i. gas is passed through separators, absorbers, coolers, and residue scrubbers, finally mixing with the 60 p.s.i. black oil gas which has passed through a low pressure gas compressor.

The rich adsorption oil is stripped after heating to 500° F passed through heat exchangers, and eventually the lean oil is pumped back to the absorbers. The overhead product is raw natural gasoline. Total absorption oil circulation rate is 500 gal/min, make-up oil being 80 gal/day.

Two cooling towers are provided, heat loads being 38,000,000 B.Th.U. and 70,000,000 B.Th.U/hr. Nine 600-h.p. two-cycle gas-driven compressors are installed, the suction and discharge piping being free from expansion loops, special type clamps are used. A patent pulsation dampener is fitted to all cylinders discharging at 1500 and 4000 p.s.i.

The well effluent is metered, and a gas stream is diverted through a test separation

unit, and from data obtained a gas–oil ratio and per cent water cut determined, and from analyses the effluent composition is found. G. A. C.

## Cracking.

**1262. Improved Design of Houdry Reactor Results in Higher Gasoline Output.** R. C. Lassiat and C. H. Thayer. *Oil Gas J.*, 3.8.46, **45** (13), 84.—Improvement in the Houdry catalytic-cracking process due to changes in design of reactor tubes and of the physical composition of the catalytic mass is described.

Although the conventional design has proved satisfactory over several years, analysis of heat transfer in the reactor and study of difficulties in maintenance and changing of catalyst have led to the new design.

The changes were made in the 12-case cracking plant at the Toledo, Ohio, refinery of the Sun Oil Co. Previously catalyst changes in a six-case plant required 20 days from offstream to onstream for the first change, and 6 to 7 weeks for the second change during, which all the tubes are removed. With the new design tube catalyst changes require only 7 to 10 days from stream to stream. The interlocking features of the fins have been eliminated and replaced by heavily welded fins, which facilitate removal of catalyst and the metal temperatures are reduced. Increased production of gasoline has resulted.

The heat capacity of the catalyst has been increased by mixing the pellets with a granular inert material of high heat capacity. Coke-burning capacity is increased, and maximum burning temperatures are reduced by the new design of reactor tubes. Figures are given for typical temperature pattern and heat liberated and absorbed in the conventional design. G. A. C.

**1263. Modern Refining Processes. Part 13. The Hydroforming Process.** G. Armistead. *Oil Gas J.*, 31.8.46, **45** (17), 85.—First commercially used in 1940, the hydroforming process became of importance during the war for the production of toluene and high-octane aviation base-blending stocks. At the present time 8 hydroforming plants exist, which are employed for improving the octane values and reducing the sulphur content of naphthas for motor gasoline production. The usefulness of the process is that the reactions induced by the coprecipitated catalyst, $Al_2O_3$ and 10% $MoO_3$, are: (1) basically those of dehydrogenation with some cyclization of straight-chain hydrocarbons, dehydrogenation of naphthenes and other molecular rearrangements, which result in large octane increase, accompanied by conversion of olefins into paraffins or ring compounds favourable to lead susceptibility; (2) the controllable production of certain selected aromatics such as toluene from a selected feed stock; (3) the decomposition of sulphur compounds present in the feed with resultant improvement in product quality.

In producing toluene from selected stocks the dehydrogenation reaction predominates, and there is no other reaction to balance the absorption of heat, such as the hydrogenation of olefins; consequently the tendency for temperature drop through the reactor is greatest, and the higher catalyst inlet temperatures are thus required for toluene operation. On the other hand, high-octane improvement operations on straight-run naphthas generally do not employ the highest inlet temperatures, although average reaction temperatures may be higher than those in the toluene operation.

A flow diagram is given and the operation is described, the naphtha feed is passed through a column for rerunning and oxygen elimination, then through a vaporizing coil to raise temperature from 950 to 1050° F and to the reactor, in which it meets a stream of recycle gas containing 60 to 80 mol % hydrogen, heated to 1050–1070° F and passes through the catalyst bed at a space velocity of from 0·5 to 1·0 at about 150 to 300 p.s.i. The product stream from reactor passes through an accumulator drum in which the hydrogen and recycle gases are separated, and the hydroformate and gas production then pass to a conventional gas-recovery system to produce a depropanized hydroformate. The recycle gas and hydrogen are passed through an absorber for hydrogen concentration before actual return to recycle gas heater. The catalyst in the reactor may be divided into a plurality of beds operated in series with reheating furnace coils between them or so arranged to effect parallel operation

in 3-ft beds. The reactor is kept on stream from 4 to 8 hours; the stream is then turned to another reactor, and the former is then regenerated, after purging, with flue gases plus 1–2% oxygen inlet at 700° F with outlet at 1000 to 1100° F and 250 p.s.i. The yield–octane relationships and related features, including Reid vapour pressure, are discussed and compared with normal polyforming and thermal reforming operations; hydroforming giving far superior octane improvements and yields. Coke formation ranges from 0·7% to 1·77% and the butanes produced from 3% to 7% according to severity of operation. The total $C_4$ hydroformates from 100% $C_4$ recovery, usually have a Reid vapour pressure of less than 10 p.s.i., and can be pressured with 3% to 9% butane to 10 p.s.i. to give a hydroformed gasoline of 400° F E.P. with nearly 100% yield on the feed, with no loss. It has an A.S.T.M. octane value of 68·5—*i.e.*, with an increment of 34·5. On this basis, hydroformed gasolines are producible with octane values up to 80, or by C.F.R.R. about 85, and having good lead susceptibility, 3 cc of T.E.L. raises the value to 89 A.S.T.M. or 93 C.F.R-R. The bromine number ranging from 1 to 5. Desulphurization is discussed, 90% of the sulphur present is said to be eliminated, the $MoO_3$ forming a sulphide which is burned off in the regeneration. The actual measure of reaction severity is the average catalyst temperature rather than the composite vapour inlet temperature. W. H. C.

## Special Processes.

**1264. Action of Ethylene Oxide on Benzenoid Hydrocarbons.** J. Colonge and P. Rochas. *Comptes Rend.*, 1946, **223**, 403.—Ethylene oxide reacts with aromatic hydrocarbons at 0° C in the presence of catalysts—*e.g.*, aluminium chloride, ferric chloride, boron trifluoride—to form arylethanols, and at higher temperatures with a second molecule of hydrocarbon to form symmetrical diarylethanes. The best yields of arylethanols—*ca.* 50%—are obtained by using ethylene oxide, aromatic hydrocarbon, and aluminium chloride in the molar proportions 1 : 10–11 : 0·9 and by working at 0–5° C. A part of the ethylene oxide (35–45%) is recovered as chlorethanol, and the reaction is believed to proceed by reaction of catalyst with ethylene oxide, liberating hydrogen chloride and forming a complex which then reacts with the aromatic hydrocarbon. The hydrogen chloride reacts with excess ethylene oxide to form chlorethanol, which does not participate further in the reaction.

With alkylbenzenes—*e.g.*, toluene, ethylbenzene, xylenes—the isomeric arylethanols formed are in accordance with theory.

The reaction is inhibited by the presence of halogen or nitro-groups in the benzene ring. G. H. B.

## Safety Precautions.

**1265. Chemical Health Hazards in Modern Petroleum Refining.** R. G. Benson and P. M. Van Arsdell. *Oil Gas J.*, 17.8.46, **45** (15), 95.—A summary of the known physiological reactions to hydrocarbons in general is given, together with available facts regarding the reactions of other compounds in frequent plant use.

The first of eight tables summarizes possible effects of the paraffin and olefin series on the human body. Light hydrocarbons of the aliphatic series and members of the aromatic group are likely to be present in one gasoline, with all their varied physiological effects.

Table II lists the effects of the diolefines and members of the alicyclic groups. Frequent blood-tests and urine analyses should be made of operators on plants producing aromatic compounds.

Lower members of the aromatic series are dealt with in Table III, whilst Table IV shows petroleum fractions and the hydrocarbons contained therein. It is noted that the skin irritant action increases as the number of carbon atoms increases from $C_5$ to $C_{12}$, whilst aromatic hydrocarbons add toxic and cumulative effects to the gasolines.

Table V gives the toxicity of various concentrations of hydrogen sulphide, and the possible effects of catalysts are shown in Table VI.

The dangers of the treating processes, such as Thylox, Unisol, Duo-Sol, and Phenolate, are summarized in Table VII, whilst additives such as tetraethyl lead and ethyl nitrite are the subject of Table VIII. G. A. C.

# PRODUCTS.

## Chemistry and Physics.

**1266. Heats of Formation and Combustion of the Normal Alkyl*cyclo*pentanes and *cyclo*-Hexanes and the Increment per $CH_2$ Group for Several Homologous Series of Hydrocarbons.** E. J. Prosen, W. H. Johnson, and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, 1946, **37**, 51.—Values are given for the heats of formation and combustion at 25° C for *cyclo*pentane and 16 alkyl*cyclo*pentanes together with *cyclo*hexane and 16 alkyl*cyclo*hexanes, in the liquid state through normal butyl and in the gaseous state through normal hexadecyl, with equations to yield values for all the higher members of both series in the gaseous state.

The increment per $CH_2$ group is compared for the lower members of several normal alkyl homologous series, including paraffins, mono olefins (1-alkene) alkylbenzenes, alkyl*cyclo*pentanes, alkyl*cyclo*hexanes, and alkyl acetylenes (1-alkyne).

A comprehensive bibliography is included. T. M. B. M.

**1267. Heats, Equilibrium Constants, and Free Energies of Formation of the Mono-Olefin Hydrocarbons.** J. E. Kilpatrick, E. J. Prosen, K. S. Pitzer, and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, 1946, **36**, 559.—For ethylene, propylene, each of the 4 butenes, 6 pentenes, and 17 hexenes, and for the higher normal 1-alkenes, values are presented for the following thermodynamic properties to 1000° or 1500° K: The heat of formation from the elements, $\Delta Hf°$; the free energy of formation from the elements, $\Delta Ff°$; and the logarithm of the equilibrium constant of formation from the elements, $\log_{10} Kf$. For each of the 6 pentenes and 17 hexenes values are also given to 1000° or 1500° K, for the following properties: the heat-content function $(H° - H_0°)/T$; the free energy function $(F° - H_0°)/T$; the entropy, $S°$, the heat content, $H° - H_0°$; and the heat capacity, $C_p°$.

Equilibrium constants and concentrations are given in tabular and graphical form for the isomerization of the 4 butenes, 6 pentenes, and 17 hexenes, as a function of the temperature to 1000° or 1500° K. Equilibrium constants are also given in tabular and graphical form for some reactions of hydrogenation, dimerization, and alkylation. 16 references to the literature are appended. T. M. B. M.

**1268. Heats of Formation, Hydrogenation, and Combustion of the Mono-Olefin Hydrocarbons through the Hexenes, and of the Higher 1-Alkenes, in the Gaseous State at 25° C.** E. J. Prosen and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, 1946, **36**, 269.—For ethylene, propylene, the four butenes, the 6 pentenes, and the 17 hexenes, and all the higher 1-alkene hydrocarbons, in the gaseous state at 25° C, values are given for the heats of formation (from the elements solid carbon (graphite) and gaseous hydrogen), the heats of hydrogenation in the gaseous state, and the heats of combustion (in oxygen to form gaseous carbon dioxide and liquid water). The values for 2 of the pentenes, 14 of the 17 hexenes, and all the higher 1-alkene hydrocarbons were calculated by a method involving correlation of the heat of hydrogenation with structure and the use of constants evaluated from the available experimental data on 4 butenes, 4 pentenes, 3 hexenes, and 1 heptene. 23 references to the literature are appended. T. M. B. M.

**1269. On the Course of the Reaction at 100° C in the Systems Xylene/Oxygen and Aromatic-Free Mineral Oil/Xylene/Oxygen.** D. J. W. Kreulen. *J. Inst. Petrol.*, 1946, **32**, 525–528.—The oxidation of xylene and of mixtures of aromatic-free mineral oil and xylene has been investigated. The formation of both peroxides and aldehydes is linear with respect to time, whole acid formation appears to increase with the square of the time. A gradual change in oxidation behaviour with increasing percentage of one of the components is observed in mixtures of xylene and aromatic-free oil. In this case less aldehydes are formed than might be expected, which is explained by some retardation effect. If copper is present, the peroxides are destroyed during the oxidation and a corresponding increase in aldehydes is found. In the case of the oxidation of pure xylene an insoluble cuprous salt of toluic acid settles from the reacting liquid. A. H. N.

**1270. On the Course of the Reaction at 100° C in the System Aromatic-Free Mineral Oil/Oxygen.** D. J. W. Kreulen. *J. Inst. Petrol.*, 1946, **32**, 515–524.—The course of the reaction at 100° C in the system aromatic-free mineral oil/oxygen has been investigated. A new apparatus for the oxidation under standard conditions of mineral oils is described. This makes it possible to introduce oxygen into the oil at such a rate that real reaction velocities are measured. The data obtained were analysed with the aid of the Kreulen–Ter Horst method. The underlying principles of this method are reviewed; it enables one to decide whether a substance is formed directly or via one or more intermediate stages. It appears that peroxides represent the first, carbonyl-containing compounds the second, and acids the third reaction stage. As the second reaction stage appears to occur to a greater extent than the first reaction stage it is very probable that the peroxides exert a catalytic action (chain mechanism) during the oxidation. During the oxidation of the oil the saponification number increases. It was found that this "saponification number" does not relate to esters or lactones, but only to peroxides. A linear relationship between dipole moment and oxidation time was found and explained. A mode of procedure is described which enables the accuracy with which the dielectric constant can be measured to be improved. It is based on the linear relationship which was found to exist between density and dielectric constant. A. H. N.

**1271. Motions of Molecules in Condensed Systems. II. The Infra-Red Spectra for Benzene Solid, Liquid, and Vapour in the Range from 3 to 16·7 μ.** R. S. Halford and O. A. Schaeffer. *J. Chem. Phys.*, 1946, **14**, 141.—Infra-red spectra are compared throughout the interval from 600 to 3300 wave-numbers for the same amount of benzene existing separately as solid at 3°, liquid at 8°, and vapour at 20° C. The comparison demonstrates convincingly that: (1) predictable selection rules for the solid are obeyed strictly; (2) there are no selection rules operating in the liquid phase; (3) the shift of molecular frequencies induced by successive stages of condensation is small and can be ignored in the approximation that regards the vibrations of an isolated molecule as harmonic ones; (4) the intensification of components of the spectrum accompanying changes of state proceeds as predicted qualitatively in an earlier paper; (5) all proposed complete assignments of the fundamental frequencies of benzene require revision. The components appearing in the several spectra are classified in accordance with a scheme suggested by the selection rules for the vapour and solid. J. T.

**1272. Absorption Spectrum of Fluorbenzene in the Near Ultraviolet.** S. H. Wollman. *J. Chem. Phys.*, 1946, **14**, 123.—The absorption spectrum of $C_6H_5F$ at 2750–2380 A was photographed in the first order of a three-metre grating spectrograph. As in $C_6H_5Cl$, the band system corresponds to an electronic transition $A_1, B_1$. This is an allowed transition, and O, O band is stronger than in $C_6H_5Cl$ because of the greater perturbation by the fluorine. Several progressions of totally symmetric vibrations are observed. The vibration whose excitation brings the corresponding benzene spectrum into appearance, and which shows up relatively intensely in $C_6H_5Cl$, appears in $C_6H_5F$, but is not particularly prominent. In contrast to $C_6H_5Cl$, transitions to the carbon–halogen vibration in the upper electronic state are quite strong. J. T.

**1273. The Addition of *cyclo*Hexene to Some Polycyclic Aromatic Hydrocarbons.** M. M. Buu-Hoï and P. Gagniant. *Comptes Rend.*, 1945, **220**, 326–328.—Selenium dehydrogenation of a di*cyclo*hexylnaphthalene (I) m. pt. 150–151° C, previously prepared by Pokrowskaja and Stepanzewa, gave a diphenylnaphthalene, m. pt. 235° C, which was not identical with the known 1 : 2 and 2 : 7 isomers, and which was considered to be the 2 : 6 isomer. The parent compound (I) was therefore identified as 2 : 6-di*cyclo*hexylnaphthalene, this structure being consistent with the known rules of substitution in the naphthalene series. By analogy a di-*tert.*-butyl naphthalene, m. pt. 132° C described by Zuckerwanik and Terentjewa was also assigned the 2 : 6 structure.

The main product of the *cyclo*hexylation of acenaphthene was a solid, m. pt. 84°; picrate, m. pt. 98° C, believed to be 5-*cyclo*hexylacenaphthene, and a mixture of liquid di*cyclo*hexylacenaphthenes, b. pt. 270–275° C/10 mm.

The main product from phenanthrene was a di*cyclo*hexyl derivative (II), m. pt.

210° C, picrate m. pt. 210° C decomp. Oxidation with chromic acid eliminated one *cyclo*hexyl group (from position 9 or 10) and converted the other into phenyl, the product being formulated as 3-phenyl-9 : 10-phenanthraquinone. Selenium dehydrogenation of (II) gave a diphenylphenanthrene (III) of high m. pt. (304° C), indicating a symmetrical structure. From these observations and by analogy with previous work on di-*tert.*-butylphenanthrene, (II) and (III) were assigned 3 : 9-di*cyclo*hexyl and 3 : 9-diphenyl structures respectively. It was concluded that in some cases the addition of *cyclo*hexene to polycyclic hydrocarbons follows the rule of least symmetry previously proposed for di-*tert.*-butylation. G. H. B.

**1274. Aromatic *cyclo*Dehydration.** C. K. Bradsher. *Chem. Revs.*, 1946, **38**, 447–499.—*cyclo*Dehydration reactions which yield a new fully aromatic ring through the acid-catalysed attack of a ketonic or aldehyde carbonyl group on an aromatic nucleus are defined as aromatic *cyclo*dehydrations. The known examples are classified as bicyclic and tricyclic, depending on the nature of the final product. They are further divided into naphthalene, benzofuran, thianaphthene, indole, quinoline, and isoquinoline bicyclic systems, and phenanthrene, anthracene, and acridine tricyclic systems. The general mechanism of aromatic *cyclo*dehydration reactions is discussed, the phenanthrene and anthracene systems being considered separately in greater detail. The effect of substituents on the ease of cyclization in the various systems is summarized in 12 tables of experimental results, and 154 literature references are cited. G. H. B.

**1275. Surfaces of Solids XV. First-Order Phase Changes of Adsorbed Films on the Surfaces of Solids : The Film of *n*-Heptane on Ferric Oxide.** G. Jura, E. H. Loeser, P. R. Basford, and W. D. Harkins. *J. Chem. Phys.*, 1946, **14**, 117.—Two-dimensional first-order changes, in which a gaseous film of normal heptane is transformed into another phase of lower molecular area with evolution of heat, have been discovered on subphases of ferric oxide, silver, and graphite. All the critical phenomena observed in three-dimensional systems are found to be duplicated. For *n*-heptane on ferric oxide the critical constants are : $\sigma_c$ (area) 900 $A^2$ per molecule ; $\pi$ (film pressure) 0·45 dyne $cm^{-1}$ ; and $T_c$, 29° C. The critical constants are found to depend on the nature of the solid as well as on that of the vapour. The heat of transformation at 25° C is estimated to be $12{,}000 \pm 5000$ cal. $mole^{-1}$. This value appears to be considerably higher than the 6150 cal. $mole^{-1}$ required for the formation of three-dimensional liquid *n*-heptane from its vapour at the same temperature. The volume–pressure relations are considered for the adsorption isotherm in the case in which a second- or third-order phase change occurs. J. T.

**1276. Studies in Vapour–Liquid Equilibria.** Part 1. T. T. Puck and H. Wise. *J. Phys. Chem.*, 1946, **50**, 329–339.—A new dynamic method—the condensation method—for the measurement of saturated vapour densities of liquids is presented. It may be conveniently applied to liquids with vapour pressures at least as great as 23 mm Hg and at least as small as 0·001 mm Hg. Vapour-pressure determinations at 25° C are presented for six liquids : water, 1-propanol, 1-butanol, nitrobenzene, 1 : 2-propanediol, and triethylene glycol. These values are compared with the corresponding vapour-pressure measurements obtained by other methods. In general, excellent agreement is obtained. A. H. N.

**1277. Heat-Capacity Lag in Gas Dynamics.** A. Kantrowitz. *J. Chem. Phys.*, 1946, **14**, 150.—The existence of energy dissipations in gas dynamics, which must be attributed to a lag in the vibrational heat capacity of the gas, has been established both theoretically and experimentally. The flow about a very small impact tube is discussed. It is shown that total-head defects due to heat-capacity lag during and after the compression of the gas at the nose of an impact tube are to be anticipated. Experiments quantitatively verifying these anticipations in carbon dioxide are discussed. A general theory of the dissipations in a more general flow problem is developed and applied to some special cases. It is pointed out that energy dissipations due to this effect are to be anticipated in turbines. Dissipations of this kind might also introduce errors in cases in which the flow of one gas is used in an attempt to simulate the flow of another gas. Unfortunately, the relaxation times of most of the gases of engineer-

ing importance have not been studied. A new method of measuring the relaxation time of gases is introduced in which the total-head defects observed with a specially shaped impact tube are compared with theoretical considerations. A parameter is thus evaluated in which the only unknown quantity is the relaxation time of the gas. This method has been applied to carbon dioxide, and has given consistent results for two impact tubes at a variety of gas velocities. J. T.

**1278. Application of the Methods of Molecular Distribution to Solutions of Large Molecules.** B. H. Zimm. *J. Chem. Phys.*, 1946, **14**, 164.—The equations for the thermodynamic potentials of the solvent in solutions of ordinary organic molecules are extended to solutions of large molecules by methods using continuous molecular distribution functions. Particular attention is given to the coefficient, $A_2$, of the second term in the expansion of the osmotic pressure in terms of the concentration, since this coefficient has a simple molecular meaning and is sufficient to describe the deviation of the system from ideality at low concentrations. $A_2$ is calculated by direct integration for two rigid shapes, the sphere and the long thin rod. A general expression is then developed for $A_2$ for flexible chain molecules in terms of the interactions of the segments of the chains. In favourable cases it is found possible to relate $A_2$ for a chain molecule to the solution properties of its small molecule homologues by an equation very similar to those developed by Flory, Huggins, and Miller. In general, however, interactions that depend both on the local structure and also on the overall shape of the chain molecules seriously modify such a relationship. The nature of these interactions, including the effects of branching and of limited flexibility, is discussed. It is also shown that higher coefficients in the expansion of the osmotic pressure in terms of concentration can be treated in a similar way. Comparison with experimental data confirms the general predictions of the theory both for proteins and chain polymers. J. T.

**1279. The Statistical Mechanical Theory of Transport Processes. I. General Theory.** J. G. Kirkwood. *J. Chem. Phys.*, 1946, **14**, 180.—Outlines are sketched for a general statistical mechanical theory of transport processes—*e.g.*, diffusion, heat transfer, fluid flow, and response to time-dependent external force fields. In the case of gases the theory leads to the Maxwell–Boltzmann integro-differential equation of transport. In the case of liquids and solutions it leads to a generalized theory of Brownian motion, in which the friction constant is explicitly related to the intermolecular forces acting in the system. Specific applications are postponed for treatment in later articles. J. T.

**1280. A Note on the Theory of Diffusion Controlled Reactions with Application to the Quenching of Fluorescence.** E. W. Montroll. *J. Chem. Phys.*, 1946, **14**, 202.—The principles of Smoluchowski's collision theory of reactions in solution are outlined. This theory is applicable to reactions which occur immediately on the collision of two reactant particles—that is, diffusion controlled reactions. The rate of such reactions depends on the collision frequency of reactants. In this paper an expression for the collision frequency is derived as a function of time when initially there is a Boltzmann distribution of particles around any particular reactant molecule. Both the Brownian motion of and the forces between reactant molecules are considered in the calculation. The general results are applied to the theory of quenching of fluorescence. It is shown that the quenching constant, $k_Q$, defined by

$$\left(\frac{I_0}{I} - 1\right) \Big/ n_Q = k_Q$$

(where $I_0$ is the intensity of fluorescence in the absence of quencher and $I$ the intensity in the presence of quencher of concentration $n_Q$) can be expressed as a sum of two terms, one proportional to the reciprocal of the viscosity of the solvent and the other to the reciprocal of the square root of the viscosity. J. T.

**1281. Viscosity and the Hydrogen Bond. Hydroxyl and *ortho* Effects.** J. N. Friend and W. D. Hargreaves. *Phil. Mag.*, 1945, **36**, 731.—Two important factors are found to influence the relative viscosities of the isomerides—namely, intramolecular struc-

ture and intermolecular association. It appears that the more symmetrical the molecule the lower are its viscosity and density, and in the case of intermolecular association, whether as the result of hydrogen bonding, dipole attraction or Van der Waals' forces, the viscosity is increased. Since the liquids containing " free " hydroxyl are often highly associated, the viscosity is greatly increased when introducing hydroxyl into the molecule. The *ortho* effect due to hydrogen bonds differs from that due to symmetry in that the viscosity, density, latent heat, and rheochor of the *ortho* derivative are reduced, and may even be less than those of its *meta* and *para* isomerides.

The rheochor is defined as $M(10^8\eta)^{\frac{1}{4}}/(D + 2d)$, where $M$ is the molar weight, $D$ and $d$ the density of the liquid and vapour, $\eta$ being the viscosity. When the rheochor is plotted against the temperature it is found that the curve falls off as the temperature rises from the melting point, reaching a constant value, and this is independent of whether the substance is associated or monomeric. This is attributed to the breaking down of ordered liquid structure or molecular orientation, such as normally occurs prior to solidification. When the rheochor is constant it may be taken that both the symmetry and degree of association are constant. If, however, the observed rheochor is equal to the sum of the constituent rheochors the substance is essentially monomeric. The rheochor thus offers useful indications of the presence or absence of association.

J. T.

**1282. On the Application and Derivation of the New Viscosity–Temperature Relationship of Liquids.** M. S. Telang. *J. Phys. Chem.*, 1946, **50**, 373–386.—In a previous paper the formula

$$\frac{1}{\eta} = \frac{m}{(1 - T_r)^{2/15}} - k$$

was derived, where $\eta$ and $T_r$ are the viscosity and the van der Waals reduced temperature respectively, and $m$ and $k$ are constants. This equation is now changed to

$$\frac{1}{\eta} = \frac{A}{(T_c - T)^{2/15}} - k$$

where $T_c$ and $T$ are the absolute critical and observation temperatures respectively. The viscosity of several liquids as it is represented or not by the latter formula and the probable interpretation of the deviation of the actual behaviour of liquids from that predicted by the formula are discussed. The literature on the mechanism of liquid viscosity and derivation of different formulæ is summarized. A. H. N.

**1283. Fuel Combustion Characteristics.** *Refiner's Notebook*, No. 105. W. L. Nelson. *Oil Gas J.*, 10.8.46, **45** (14), 115.—The calorific values, ratios of air to fuel required for combustion at 0% excess air and the per cent carbon dioxide after combustion, the ultimate analysis, and A.P.I. gravity are given for 20 liquid fuels derived from different cracked and straight-run crude oils, petroleum coke, and 2 bituminous coals. Similar data are shown for 13 gaseous fuels, including both wet and dry, cracked gases, and 3 natural gases, for which the density is given in place of A.P.I. gravity.

W. H. C.

## Analysis and Testing.

**1284. Precision Semimicromethod for Gas Analysis.** L. K. Nash. *Industr. Engng Chem. Anal.*, 1946, **18**, 505–508.—An apparatus is described which is capable of complete analysis of small samples of carbon dioxide, carbon monoxide, methane, hydrogen, nitrogen, and/or oxygen. The operations of analysis are simple and reliable, and the danger of loss of a valuable sample is reduced to a minimum. With a sample of volume approximating 1 c.c. at N.T.P. an accuracy of a few tenths of a per cent of the total gas sample may be anticipated; but an accuracy of about 1% is maintained with samples as small as 0·1 cc N.T.P. The conditions for a satisfactory fractional combustion on a platinum catalyst of hydrogen and carbon monoxide in the presence of methane and excess oxygen are defined. A. H. N.

**1285. Assembly, Testing, and Operation of Laboratory Distilling Columns of High Efficiency.** C. B. Willingham and F. D. Rossini. *Bur. Stand. J. Res. Wash.*, 1946, **37** (1), 15.—An account is given of the assembly, testing, and operation of the labora-

tory distillation columns used at the National Bureau of Standards in the work of the A.P.I. Research Project 6 on analysis and purification of hydrocarbons and in the work on the preparation of standard samples of hydrocarbons.

These distillation columns have charging capacities of from ½ to 15 litres, with separating efficiencies in the range 100 to 200 equivalent theoretical plates at total reflux. Distillations are performed continuously 24 hr/day, 7 days/week, with reflux ratios of from 125/1 to 180/1 and rates of removal of product ranging from 2–12·5 ml/hr. Total distillation time given ranges up to 1800 hr.

A description is given of assembly of columns, including pot, rectifying system, jacket, head, reflux regulator, receiving assembly, electrical heating system; thermometric systems, and controlled pressure system; testing of columns, including test mixtures and results; and operation of columns, for both regular and azeotropic distillations.

Drawings of the equipment and apparatus are given, including the arrangement of the 15 distillation columns, measuring instruments, and auxiliary equipment in the distillation room. A photograph of the distillation room is given. T. M. B. M.

**1286. Molecular Weight and Mercaptan Content of Mixtures of Primary Mercaptans.** H. A. Laitinen, A. S. O'Brien, and J. S. Nelson. *Industr. Engng Chem. Anal.*, 1946, **18**, 471–472.—The mercaptan sulphur content of a mixture of primary mercaptans is determined by titration with silver nitrate, and the weight of silver mercaptide formed during the titration is determined. From these data the average molecular weight of the mercaptans and the percentage of mercaptans is calculated. The percentage of non-mercaptan material is found by difference. A table of experimental results against corresponding calculated values from other evidence shows that the method yields the correct molecular weight to an accuracy of 1 to 2 units of molecular weight (0·5% to 1%). The method is reproducible to ± 1 unit of molecular weight. A. H. N.

**1287. Movement of a Thin Plate in Non-Newtonian Liquids.** E. W. J. Mardles. *Nature*, 1946, **158**, 199.—The rate of fall of a steel ball through non-Newtonian liquids such as grease decreases to zero at some depth below the surface dependent on the weight of the ball. This effect is attributed to the rigidity of the system at greater depths, at which more energy is required. A thin plate should be free from this volume-displacement difficulty. When such a plate—a double-edge razor blade—was drawn edgewise through grease with constant force its velocity was constant; and by using different forces the yield value of the grease could be determined.

The viscous drag on such a plate, even by liquids like water, can be demonstrated by suspending it from a balance beam by a quartz thread in the liquid, which is then run out from the bottom of the containing vessel. H. C. E.

**1288. Viscosity by Various Instruments—Low Range.** *The Refiner's Notebook*, No. 108. W. L. Nelson. *Oil Gas J.*, 31.8.46, **45** (17), 103.—A tabular comparison is given for kinematic viscosities from 1·5 to 40 cs, with Saybolt Universal viscosities at 100, 130, and 210° F, and Engler degrees and Redwood Standard No. 1 viscosities for the range 4·0 to 40 cs; and the approximate viscosity values for the range 1·5 to 3·5 cs. The comparison with Saybolt Furol and Redwood Admiralty No. 2 are given as approximate values for the ranges 21 to 40 and 30 to 40 cs respectively. W. H. C.

**1289. A Viscometer with Constant Working Volume, Suitable for Measurements over a Wide Range of Viscosities.** W. D. Hargreaves. *Phil. Mag.*, 1945, **36**, 756. J. T.

**1290. Measurement of Viscosity.** Anon. *Nature*, 1946, **158**, 244–5.—The errors associated with various types of viscometer are pointed out, and discrepancies in the results of different observers attributed to differences in surface tension of the standard calibration liquids. The viscosity of non-Newtonian liquids might be measured by studying the wave motion of a vibrating liquid system. X-ray photography confirms the fact that balls falling through non-Newtonian liquids may eventually remain suspended (see Mardles, *Nature*, 1946, **158**, 199.—Abstr. No. 1287). H. C. E.

**1291. Application of Variance Analysis to Some Problems of Petroleum Technology.** H. M. Davies. *J. Inst. Petrol.*, 1946, **32**, 465–491.—The importance of measuring variation in experimental data is emphasized and some methods of handling variable material and coping with variable conditions are described, in particular the statistical technique developed by R. A. Fisher and known as the analysis of variance. The fluctuation of octane ratings is typical of the variation met with in experimental work. After an indication of the underlying statistical ideas the arithmetical procedures involved in variance analysis are briefly outlined, using 20 rich mixture ratings by the British 3-C method as an example. These are first treated as 2 groups of 10 results (grouped data), and then as 10 pairs (paired data), to show how the appropriate form of analysis depends on the way in which the results have been obtained.

Efficient experimental designs based on statistical methods have been developed. The randomized block arrangement illustrated by means of kerosine-burning test results secures the separation of major causes of heterogeneity so that their effects do not interfere with the comparisons the experiment is designed to make. The Latin square carried this a stage farther, giving control of error in two directions simultaneously. This is illustrated by a test of the m.p.g. performance of 7 motor fuels, and the example is also used to introduce the idea of covariance. It is shown how the results themselves can be made to supply whatever correction is appropriate for the effect of a concomitant variate. Stress is laid on the unity of experiments, their plan, operation, analysis, and final interpretation. A. H. N.

## Engine Fuels.

**1292. British Aviation Fuel Manufacture in the Middle East—Part II.** Anon. *Industr. Chem.*, 1946, **22**, 518–524.—An account is given of the various new (1939/42) manufacturing processes conducted at Abadan and the modification of redundant plant and spares to construct the units, made necessary by war conditions. F. S. A.

**1293. Processes for Octane Improvement.** D. Read. *Petrol. Times*, 20.7.46, **50** (1278), 757.—The various processes for improving the octane rating of gasolines are reviewed. Among the most important of these are: (1) desulphurization of gasoline; (2) conversion of gasoline hydrocarbons by reforming; (3) conversion of hydrocarbons heavier than gasoline by cracking.

Polymerization or alkylation of the gases produced by cracking or reforming may be classified as complementary processes, which also increase the octane rating of the total gasoline blend.

The paper describes several processes which may be used to increase octane rating by the above methods, and discusses the application of each process. Some attempt is made to compare the processes which are discussed, but the type of crude to be refined and the yield and quality of products other than gasoline which are to be produced will affect the application of each process for octane improvement.

R. B. S.

## Gas Oil and Fuel Oil.

**1294. Combustion of Catalytically Cracked Distillates, and New Burner Design Widening Markets for these New Fuels.** S. R. Cauley and H. R. Linden. *Oil Gas J.*, 10.8.46, **45** (14), 80.—Difficulties are encountered when burning catalytically cracked fuels in pot-type burners where the carbon and soot formation is brought about by cracking through unsatisfactory combustion conditions. The cracking characteristics and oxidation reactions of paraffins and aromatics are discussed, and it is shown that paraffins are primarily decomposed by cracking to products of smaller molecular weights than the original material cracked, whilst aromatics (benzene and naphthalene) under moderate cracking give products of higher boiling-points; under severe cracking both higher and lower boiling-point products are formed. Complete oxidation of paraffins even at moderate temperatures is relatively easy without the formation of carbon. The oxidation of aromatics without the formation of carbon is shown to be possible by only one procedure—a progressive oxidation (of benzene), which is discussed. It is difficult without the aid of a catalyst, as the temperatures required were nearly the same as those at which decomposition of benzene takes place.

The carbon deposits on the bottom and sides of a pot-type burner are discussed from the aspects of the preceding information, and indicated the need for accomplishing the following in a burner modification: (1) vaporization of fuel with as little cracking as possible; (2) intimate mixing of primary air and oil vapours as soon as possible following vaporization; (3) reduction of temperature in the lower sections of the pot so as to attempt a progressive type of oxidation of the aromatics with a minimum soot formation. A pot-type burner of 50,000 B.Th.U per hour rating was modified with a view to accomplish these factors, and is described with the reasons for the changes to the several components—viz., the central oil inlet, the radiation shield, the central baffle, and the secondary air ducts (see Abstract No 978). The performance of the original and modified burners when burning the heaviest catalytically cracked fuel are given and shown in graphs. Comparisons of draughts required; carbon accumulations; plots of air distribution study and operating draft curves found necessary for good burner performance; covering fuel rates of 1 to 3·5 lb/hr., stack drafts of 0·02 to 0·08 in water, percentage $CO_2$ in flue gases, stack temperatures, per cent efficiency, and smoke per cent (I.C.H.M.). The I.C.H.M. (Institute of Cooking and Heating Appliance Manufacturers) smoke-rating method is described. The conclusions drawn from the studies are: (1) a burner modification of a pot-type burner has been effected which has been shown to operate satisfactorily with a highly cracked distillate fuel over a major portion of the oil-burning rates normally employed in such equipment and found to give full rated capacity of the burner; (2) the method of modification indicates some reorientation of ideas and experimentation on the part of pot-type burner manufacturers; they may be able to modify their equipment so as to handle less expensive grades of fuel oil than those currently required.

W. H. C.

**1295. Diesel and Boiler Fuel.** Anon. *Motor Ship*, Oct. 1946, **27** (321), 265.—A review is given of the present prices and probable trend, together with the factors influencing cost. An interesting comparison is made between boiler fuel, diesel oil, and coal on August 1 and September 1 at various ports. The Petroleum Press Service is quoted in disabusing any fears of a shortage of oil fuel. I. G. B.

## Bitumen, Asphalt, and Tar.

**1296. Commercial Evaluation of French Asphalts.** M. Louis. Paper presented to L'Association Français des Techniciens du Petrole. Undated. Pp. 22.—The six regions of France in which asphalt occurs in amounts sufficient for exploitation were described, with maps and geological sections showing the location of test borings, asphalt indications, mining operations, and the geological structures of the regions.

The composition of asphalts was briefly discussed with respect to elementary composition and the principal constituents, based on Marcusson's classification, using both previous and new data on French asphalts. Comparative figures for a Trinidad asphalt were quoted to show the generally higher oil contents of the French asphalts.

Crude liquid products were obtained in 55% to 65% yield, based on asphalt by the pyrolysis of 2 asphalts, 3 asphaltic limestones, and an asphaltic sand at an optimum temperature of 370° C. The products were fractionated at atmospheric pressure to remove crude gasoline and kerosine components and the residue boiling above 300° C redistilled under high vacuum to give, after chemical refining, luboils with viscosity indices of *ca.* − 20, in yields of 15% to 30% based on the crude pyrolysis products.

Two asphaltic limestones and 2 sands were pyrolysed at 360° C with injection of superheated steam to give crude oils in 70% to 75% yield based on their asphalt contents. The products were fractionated and the heaviest fractions redistilled under high vacuum and chemically refined to give lubricating oils with viscosity indices ranging from − 45 to + 47, the products of highest V.I. being obtained from Gard asphaltic limestone. Lubricating oil yields were 40% to 60% based on the crude steam-assisted pyrolysis products.

It was concluded that a complete range of industrial lubricants could be produced in significant amounts from selected French asphalts, but with chalk as the principal product from asphaltic limestones. The importance of such an industry to France and the French colonies was suggested. G. H. B.

## Derived Chemical Products.

**1297. Phthalic Anhydride from *o*-Xylene.** Anon. *Chem. Industries*, July 1946, **59** (1), 68.—A flow diagram of the plant used and a brief outline of the process for the manufacture of phthalic anhydride from *o*-xylene are given. *o*-Xylene derived from petroleum is fed by gear-pumps at approximately atmospheric pressure to a steam-heated vaporizer, after which it is injected into a heated air stream; the ratio of air to hydrocarbon which is dictated by the explosive limit of the mixture is kept on the lean side to avoid excessive temperature rise. The mixture then passed to a tubular-converter containing a fixed bed of a vanadium-base catalyst. The reaction is controlled by cooling with a stream of molten salt which maintains it at about 1000° F, the contact time being less than 1 second. Heat is removed from the molten salt stream by passage through a waste-heat boiler for steam generation. The product issuing from the converter is passed through a vapour cooler and then to box-like condensers with cone bottoms, down which the crystals of crude phthalic anhydride fall into an underground melting-tank, containing steam coils. The product from the melting-tank is pumped to the first of two distillation columns, the centre cut from the first being passed to the second. The bottoms and overhead stream from the first are recycled to the converter feed. The overhead from the second column passes to an aluminium tank and, still molten, is sent to the chiller in which it solidifies on a water-cooled stainless steel drum. The finished phthalic anhydride is scraped off by a knife arrangement. The yield is greater than 70%. W. H. C.

## Miscellaneous Products.

**1298. Butal May Entirely Replace Natural Rubber for Tubes.** Anon. *Oil Gas J.*, 3.8.46, **45** (13), 94.—Production of butyl rubber in 1945 was 55,000 tons, and this synthetic, chemically unlike any other type rubber, is highly resistant to the effects of sunlight, weather, air, oxygen, ozone, water, acids, alkalies, animal, and vegetable oils. Its other properties ensure long life. It is used for inner tubes, high-pressure steam hose, conveyor belts for hot materials, and pump linings. A flow chart shows the basic steps in manufacture of butyl rubber from isobutylene and normal butylene. G. A. C.

**1299. Effect of Short Contact with D.D.T. Residues on *Anopheles Gambiæ*.** L. Kartinan and M. M. Da Silveira. *J. Econ. Entom.*, June 1946, **39** (3), 356.—Experiments are described on *Anopheles gambiæ* carried out in a U.S. Army base laboratory, Dakar, French West Africa, during the period July to September 1944.

A mosquito aspirator of glass, coated on the inside surface with a density of 125 mgm D.D.T. per sq.ft, was used, a similar untreated tube being used as control.

Female *Anopheles gambiæ* were obtained from a stock colony fed on humans. Observations were taken on 60, 30, and 5 second contacts with the D.D.T. residues. Typical D.D.T.-toxicity was exhibited in less than 10 min after contact, the majority showing symptoms at between 10 and 30 min after contact. All mosquitoes were affected after 80 to 90 min contact. The females after contact with D.D.T. gave an average of over 95% mortality 8 hours after contact. 100% mortality was given by the 60-second group 9 hours after contact and by the 30-second group at between 10 and 24 hours after contact. The 5-second group showed 97% mortality at between 10 and 24 hours after contact. An extremely short contact with D.D.T. residues will kill most females, and the data also indicate that an extremely short contact with D.D.T. residues will inhibit them from taking a blood meal at between 1 and 2 hours after contact. G. A. C.

**1300. D.D.T. to Control Insects Affecting Man.** E. F. Knipling. *J. Econ. Entom.*, June 1946, **39** (3), 360.—The use of D.D.T. for controlling insects including mosquitoes, lice, fleas, and bedbugs, which affect man, is discussed.

D.D.T. can be applied as a dust, or as solution, emulsion, or suspension. Solutions of D.D.T. in petroleum oils, including lubricating oil, fuel oil, kerosine, and lighter fractions, are widely used, as also have been other types of solvents such as xylenes. Aqueous solutions have also found employment. Emulsions use xylene and other solvents.

Against mosquito larvæ and adults D.D.T. is effective at a dosage of 0·1 lb/acre,

using various types of spray equipment. Airplane sprays have been effectively used for controlling both mosquito larvæ and adults.

A 10% D.D.T. powder will control all three types of lice attacking man. Control of body-lice can be obtained by using clothing impregnated with D.D.T., even after the fabrics have been washed several times. Against flies D.D.T. in sprays and aerosols is highly efficient.

Fleas on the person and in infested quarters can be effectively eliminated; and sprays applied to beds will destroy an entire infestation of bed-bugs and prevent re-infestation for many months. G. A. C.

**1301. D.D.T. for Insect Control at Army Installations in the Fourth Service Command.** S. C. Dews and A. W. Morrill. *J. Econ. Entom.*, June 1946, **39** (3), 347.—A review of the problems of insect control in U.S. Army posts, camps, and stations is given.

Insecticides in general use in the period 1940–43 for control of insects and rodents infesting Army installations were a general-purpose spray containing pyrethrum and a sodium fluoride–pyrethrum roach powder. Flies and mosquitoes were dealt with by diesel oil and used motor oils.

By 1942 bedbug control became a serious problem, and in 1943 fumigation with HCN was authorized. 26 schools were established for training of pest-control operatives, and instruction in the use of D.D.T. followed. Costs of operations were reduced; for example, for the fumigation of company mess halls the costs were reduced from $30 to $9·20. In 1944 D.D.T. was used in practical control work in the camps, mosquitoes, flies, bedbugs, roaches, ants, flies, termites, lice, and ticks being successfully controlled. D.D.T. was applied as sprays, emulsions, and dusts, hand-operated apparatus giving the best results. Latrines, garbage racks, interiors of mess-halls, and dairy-barns were very effectively treated with 5% D.D.T. in emulsion, kerosine solution, and with 10% dust.

Termites attacking wooden posts were controlled with 5% D.D.T. in kerosine, by dipping the 4 in by 4 in uprights in the insecticide and by spraying the soil in the hole as it was refilled. Comparative tests with chlorinated toluenes, pentachlorophenol, creosote–diesel oil mixtures, and 10% sodium arsenate solution in water showed D.D.T. to be the best; whilst failures occurred with the latter two substances. G. A. C.

**1302. D.D.T. to Control Insect Pests Affecting Livestock.** Bruce and Blakeslee. *J. Econ. Entom.*, June 1946, **39** (3), 367.—Observations are made on the effectiveness of D.D.T. insecticides against several species of insects affecting livestock in the south-eastern United States during the period 1944–45.

Preliminary tests were made on 3000 head of livestock and in 14 dairy-barns, large-scale operations were conducted on 26,000 head of livestock and in 120 dairy-barns. Spraying the backs of cattle and passing the animals through a wading vat containing 2% D.D.T. emulsion successfully controlled a serious outbreak of stable flies, *Stomoxys calcitrans* (L), in central Florida. Hornflies, *Siphona irritans* (L), were controlled by two applications of 2·5% D.D.T. emulsion used as a spray, whilst one application to the interior of dairy buildings controlled houseflies, *Musca domestica* (L).

For the large-scale tests on 26,000 head of livestock water-dispersible D.D.T. powder was used at 0·23%, 0·5%, 1%, and 2·3% suspensions. The best results were obtained with 2·3% D.D.T. suspension, complete control of hornflies being obtained for 4 to 7 weeks, of the houseflies for more than 3 months when sprayed on barns, and it was effective for 3 weeks against this pest in hog-pens.

It was also completely effective against fresh-water mosquitoes and was effective against cockroaches in barns and against cattle lice. Screw-worm flies and Gulf Coast ticks were also reduced.

The use of D.D.T. on the animals did not result in any apparent injury. G. A. C.

## Engines and Automotive Equipment.

**1303. High Speed 18000 B.H.P. Fiat Engine.** Anon. *Motor Ship*, Oct. 1946, **27** (321), 266.—A description is given of a new type of Fiat double-acting engine developing 18000 b.h.p. at 310 r.p.m. The published details are:

| | |
|---|---|
| No. of cylinders | 8 |
| Cylinder diameter | 25·59 in |
| Piston stroke | 33·86 in |
| Mean effective pressure approx. | 85 lb/sq.in |
| Piston speed approx. | 1800 ft/min |
| Weight of engine | 200 tons |
| Weight per b.h.p. | 25 lb |

I. G. B.

**1304. A Small Diesel for Light Aircraft.** Anon. *Aeroplane*, 1946, **71**, 298.—A small air-cooled oil engine has been designed for use in light aeroplanes in the U.S. This is the 100 h.p. 4-cyl Thaheld-Shaffer power unit, flown recently a distance of 105 air miles in 55 minutes with a consumption of 2½ gal of light diesel fuel. It has freedom from induction icing troubles and may be opened up immediately for take-off in the same way as a gas turbine. By efficient air cooling the head temperature is 350° C at take-off and 300° C at cruising conditions. The compression ratio is 16 : 1 at sea-level and 11 : 1 at cruising altitudes, giving a 40% higher ceiling than the equivalent gasoline engine. The weight is given as 235 lb and a 6-cyl version is projected.

I. G. B.

**1305. Jet Propulsion and its Application to High-Speed Aircraft.** D. J. Keirn and D. R. Shoults. *J. Aero. Sci.*, 1946, **13**, 411.—The article explains the principles of the apparatus involved in jet propulsion for aircraft. The early development of the Whittle design is traced, together with developments in the U.S. The typical measures of efficiency of jet propulsion are developed and detailed calculations given of the thrust and pressure cycle, including ram intake, compressor performance, combustion equations, and turbine and nozzle thermodynamic equations. Typical thermal jet-propulsion cycles are illustrated by diagrams, including specific engine performance in all its complicated forms.

I. G. B.

**1306. Bristol Theseus I.** Anon. *Aeroplane*, 1946, **71**, 307.—The Theseus has an axial plus centrifugal compressor driven by the first two turbine stages. The third-stage turbine drives the airscrew through an epicyclic reduction gear. Heat from the exhaust gases is transferred to the air leaving the compressors by a heat exchanger situated inside the triangulated engine mounting. The residual gases form additional jet thrust. The engine has recently completed a 100-hour endurance test, and is now being prepared for flight testing in an Avro Lincoln.

The heat exchanger weighs about 500 lb, and it is claimed that after several hours flying it can save this weight in fuel. The main power is transmitted from the third-stage turbine to a conventional 4-bladed tractor propeller. The ratio of power used is 80% to the propeller and 20% as jet thrust at 300 m.p.h. The compressors give a compression ratio of 5 : 1 at 300 m.p.h. and 20,000 ft altitude. At sea-level static conditions the compressor runs at 8200 r.p.m. and delivers 30 lb/sec of air for a power consumption of about 3500 h.p. The gas temperature at turbine inlet does not exceed 800° C.

Leading particulars are:

Length 112 in
Diameter 48 in
Weight (net dry) 2310 lb
Performance: Output at S.L. 1950 s.h.p./hr + 500 lb S.T.
Fuel consumption at S.L., 300 m.p.h., 0·57 lb/s.h.p./hr max. cruise or 0·5 lb/s.h.p./hr at 20,000 ft at 300 m.p.h.
Oil consumption 3 pints/hr.

I. G. B.

**1307. Mamba Gas Turbine.** Anon. *Aeroplane*, 1946, **71**, 293.—Preliminary details are given of the Armstrong-Siddeley Mamba gas turbine. The engine has been produced to give a sea-level take-off performance of 1000 s.h.p. plus 320 lb static thrust. This is approximately equivalent to a take-off power of 1120 h.p. in a reciprocating engine. The diameter over cowling is 27 in and weight 750 lb or a frontal area of some 30% of the equivalent piston engine and a weight saving of 25%. The

installed weight of the Mamba is expected to be about 50% that of a corresponding piston-engine installation.

The compressor is the axial type, and flow is straight through, the combustion chambers being six in number. I. G. B.

**1308. Marine Gas Turbines.** Anon. *Motor Ship*, Oct. 1946, **27** (321), 243.—Reviews projected gas turbine sets for ships.

1. An authoritative statement by the chairman of John Brown and Co. indicates the design of gas turbines in the near future;

2. A 3000-b.h.p. turbine is being installed in a converted Liberty ship in America, and two more vessels are under construction for the U.S. Navy in which gas turbines will be fitted.;

3. A British tanker is being built to be equipped with four diesel generating sets supplying current to a single propeller, and one of these units will be replaced by a 1200-h.p. gas turbine when the necessary tests have been carried out. This is being built by the B.T-H. Co.;

4. Metro-Vickers are building a gas turbine to replace one gasoline engine in a motor-torpedo boat;

5. C. A. Parsons have built a 500-b.h.p. plant;

6. Brown Boveri have completed tests on a 15,000-h.p. gas turbine driving a 10,000-kW generator;

7. Sulzers will have a 7000-h.p. marine unit available for trials next year;

8. Escher-Wyss have run an experimental plant for some years;

9. In Sweden a 2500-h.p. gas turbine will be completed within a year.

Hitherto thermal efficiencies above 25% have not been exceeded. Sulzers hope to exceed 30%. Competition between diesel and gas turbines depends on the exclusive use of boiler oil with gas turbines, and this is claimed to be a feasible proposition by all the manufacturers concerned. The claim has yet to be substantiated over a long period, and a relatively low ash content may have to be specified with the oil utilized. I. G. B.

**1309. Comparison of Propeller and Reaction-Propelled Airplane Performances.** B. Hamlin and F. Spenceley. *J. Aero. Sci.*, 1946, **13**, 425.—For this paper four power-plants having distinctly different performance characteristics were chosen:—1. A V-type reciprocating liquid-cooled engine incorporating water injection for emergency power; 2. A turbo-jet engine having about 23% less sea-level static thrust than the former; 3. A hypothetical subsonic ram-jet; 4. A bi-propellant liquid fuel rocket motor.

Since the characteristics of the four power plants were so different, it was necessary to relate their performance to specific airplane designs, and these hypothetical designs were specified. The conclusions reached are:

"1. Propeller Airplane. (*a*) A practical maximum speed limitation not much in excess of 500 m.p.h. is apparent. Maximum speeds obtain in the 20,000 to 30,000-ft range; (*b*) Because of superior range, the propeller type of propulsion cannot be supplanted at the present time. Maximum range is relatively insensitive to altitude up to engine critical altitude; (*c*) Greater pay loads possible in addition to range make commercial application and long-range bombers most attractive; (*d*) Cruising and climbing speeds are slow; (*e*) Operation above 40,000 ft appears impractical except possibly in the case of power plants incorporating the gas turbine; (*f*) Maximum rate of climb occurs at sea level; (*g*) Further improvements, adaptations, and variations will be widely developed in terms of compound and gas-turbine engines and various combinations of them.

"2. Turbojet Airplane. (*a*) High maximum speeds where relatively short range is required make this airplane mandatory for military application. Maximum speed occurs at sea level; (*b*) again, for short-range premium operation in commercial fields this power plant is attractive. Range improves markedly with altitude, and economical cruising speeds are relatively high; (*c*) relatively high operating altitudes—at least up to 50,000 ft—are feasible. At high altitudes respectable range is obtained; (*d*) maximum speed of the order of 550 to 600 m.p.h. and above at sea level is ideally suited for air-to-ground military operation; (*e*) maximum rate of climb occurs at sea level; (*f*) speeds for maximum rate of climb are reasonably high.

" 3. Ram-Jet Airplane. (*a*) Maximum speed, of the order of 650 m.p.h., occurs at sea level; (*b*) climbing speeds are exceptionally high, being within 5 to 10% of maximum level-flight speeds; (*c*) range is extremely limited, representing some 50% of that for the turbojet, and also increases considerably with altitude; (*d*) maximum rate-of-climb at sea level is exceptionally high, but falls off rapidly with increase in altitude, resulting in a rather low ceiling—below 40,000 ft; (*e*) auxiliary take-off means are required; (*f*) performance characteristics indicate that the ideal application would be in the field of low-altitude, flat-trajectory missiles against such targets as battleships and aircraft carriers in particular. Air launching would probably be more practical than surface launching.

" 4. Rocket Airplane. (*a*) This is the only man-carrying airplane capable of flight at supersonic speeds, which distinguishes this type of propulsion from the others considered; (*b*) range is extremely limited, and increases slightly with altitude; (*c*) as in the case of maximum speed, so also does rate-of-climb increase phenomenally with altitude; (*d*) ceiling, speed, and climb performance are limited only by the amount of fuel it is possible to carry; (*e*) performance characteristics indicate ideal application to missiles following a trajectory. Peak altitudes greatly exceeding the capability of any other man-made mechanisms are possible. Missile ranges can be vastly extended; (*f*) highly specialized applications in terms of research airplanes and interceptors are evident. A research airplane could be used to conduct tests in level flight for application to high-speed and diving problems encountered on other types of airplanes. Target-seeking interceptor missiles powered by rocket motors should be most effective.

I. G. B.

**1310. Turbines at the S.B.A.C. Show.** Anon. *Flight*, 1946, **50**, 275.—Details of the performances of the following engines are given: Armstrong Siddeley Python, X., and Mamba; Bristol Theseus I; Metrovick F2/4; D. H. Goblin I, Series II; Rolls Royce Derwent V, and Nene I; De Havilland Ghost I, Series II. I. G. B.

**1311. Piston Engines Displayed at S.B.A.C. Show.** Anon. *Flight*, 1946, **50**, 275.—Details of the following engines are given: Alvis Leonides; Blackburn Major III; Blackburn Minor II; Bristol Centaurus 57; Bristol Hercules 630; De Havilland Queen 70; De Havilland Major 50; De Havilland Major 10; Monaco; Napier; Rolls Royce Merlin 620; Rolls Royce Griffon 67. I. G. B.

**1312. Aero Engines on Show at Radlett.** Anon. *Aeroplane*, 1946, **71**, 370.—Type, dimensions, weight, and performance of the following engines are listed: Alvis Leonides; Armstrong Siddeley Python; Armstrong Siddeley A.S.X.; Armstrong Siddeley Mamba; Armstrong Siddeley Cheetah X; Bristol Theseus; Bristol Hercules 630; Bristol Centaurus 57; Bristol Pegasus 38; Cirrus (Blackburn) Minor Series II; Cirrus (Blackburn) Major II; Cirrus (Blackburn) Major III; De Havilland Goblin II; De Havilland Ghost II; De Havilland Gipsy Major 10; De Havilland Gipsy Queen 51 and 70; Metro-Vickers F2/4; Monaco; Napier Sabre VII; Rolls Royce Derwent V; Rolls Royce Nene; Rolls Royce Civil Merlin 620; Rolls Royce Griffon 67. I. G. B.

**1313. British Aircraft at Radlett.** Anon. *Aeroplane*, 1946, **71**, 368.—Technical details are given of the civil and military aircraft on show. Information is given under the following headings: Manufacturer; aircraft; type; accommodation (crew and passengers); span O.A.; length O.A.; height O.A. at rest; gross wing area; all-up weight; standard fuel capacity; max. W.M. cruising speed; representative range and payload; engines; sea-level take-off b.h.p. per engine; max. r.p.m.; airscrew reduction gear; airscrews; diameter; no. of blades. I. G. B.

**1314. Precision Sheet-Metal Work.** Anon. *Aircraft Production*, Oct. 1946, **8** (96), 45.—The first article on the manufacture by Joseph Lucas, Ltd., of sheet-metal assemblies for gas turbines appeared in the September issue of *Aircraft Production*, and reviewed the production of the combustion-chamber flame-tubes. This second and final article is concerned with the turbine nozzle-ring assemblies and the exhaust units. Some of the operations on the machined parts of the assemblies are also briefly described. I. G. B.

## MISCELLANEOUS.

**1315. Shell Planning to Build New Refinery in British North Borneo.** Anon. *Oil Gas J.*, 10.8.46, **45** (14), 61.—A brief outline is given of the Royal Dutch Shell Co's reconstruction of their properties in the Far East since their liberation from the Japanese occupation. The companies concerned, location, state of fields and refineries when recovered, and the progress made since in production and refinery operations, together with new wells to be drilled and new refineries planned, are shown and discussed, covering Sarawak, Borneo (Brunei, Tarakan, Malikpapan, Miri), and New Guinea (Vogelkop fields). What is known of the condition of properties and refineries in Sumatra is noted. Technicians are gathered at Batavia, Java, awaiting the political settlement of Sumatra's difficulties, to take up the work of reconstruction at Palembang, Pladjoe, Soengaigerong, and the oilfields in the Djambi district. W. H. C.

**1316. Oil in France.** Anon. *Petroleum*, 1946, **9**, 133.—A review of the present position in the French oil industry. K. C. G. K.

**1317. Petroleum Statistics of Argentina.** Anon. *Bull. S. Amer. Inst. Pet.*, 1946, **2**, 285–304.—Annual production of crude oil in the Republic for the last 38 years is given, together with details of refinery operations and movements of refined products. A. C.

**1318. Full-Scale Petroleum Refining in the United Kingdom.** Anon. *Times Trade and Engineering*, 1946, **59** (991), 8.—A reply to the arguments put forward by Lord Bearsted in his recent annual statement to "Shell" stockholders. The arguments against U.K. refining are quoted and individually critically examined. It is considered that the cheaper rates for crude transport, as against those applicable to refined products, compensate for refining losses and fuel consumption. Specialized refining, as advocated by Lord B., would deprive the U.K. of valuable refinery by-products. U.S.A. practice favours large refineries at the consuming centre; such a policy is rendered feasible by the flexibility of modern refining operations. V. B.

**1319. U.K. Petroleum Imports in June and the Half Year.** Anon. *Petrol. Times*, 3.8.46, **50** (1279), 805.—Statistical data on imports and exports (including oil fuel bunkering of shipping) of crude oil and refined products for June and the first half of 1946 are presented, together with comparative figures for 1945 and 1938. R. B. S.

**1320. U.K. Petroleum Consumption and Customs Yields.** Anon. *Petrol. Times*, 3.8.46, **50** (1279), 820.—Statistical data on hydrocarbon oils retained for home consumption and the customs duty yield are presented for the calendar years 1940 to 1944 inclusive. R. B. S.

**1321. Light on Decline in U.K. Oil Export Trade in Wartime.** Anon. *Petrol. Times*, 17.8.46, **50** (1280), 868.—Statistical data on exports of refined products are presented for the calendar years 1938 to 1944 inclusive. R. B. S.

**1322. How Smoke Screens were Rapidly Developed in Britain.** S. R. Dight. *Petrol. Times*, 17.8.46, **50** (1280), 876.—The wartime use of petroleum for smoke screens is discussed. R. B. S.

# REVIEWS AND BOOKS RECEIVED.

**Metodui Ispuitaniya Nefteproduktov. (Methods for the Testing of Petroleum Products).** 1946: Moscow-Leningrad. Pp. 415. 26 rubles.

This publication is the Russian equivalent of our own "Standard Methods" and of the A.S.T.M. "Methods of Testing." It is issued by the Petroleum Division of the Council of Peoples Commissars of the U.S.S.R. It is of interest to note, as some indication of the scope of the oil industry in the U.S.S.R., that the edition amounts to 7000 copies. The present issue has been compiled by A. A. Al'tman

and E. V. Starikova. The methods quoted are those laid down as General Union Standards (O.S.T. or G.O.S.T.) by either the All-Union Standards Committee (V.K.S.) or the People's Commissariat for Heavy Industry (N.K.T.P.).

The volume is divided into four sections, dealing with general testing methods (66 methods), methods for the examination of solid and anti-corrosive lubricants (greases) (25 methods), methods for the testing of petroleum by-products (25 methods) and finally a section on sampling. All the test methods are laid out according to a standard plan, comprising a brief introductory paragraph, an indication of the scope of the method, an outline of the procedure, a list of the reagents and equipment required, and finally instructions for carrying out the test and reporting the result. As is usual, each method is identified by a combination of letters indicating the body under whose authority it is issued, a number, and the date on which it was approved. Limits of accuracy and repeatability are given in most cases. The tests in the main follow the usual pattern—in some cases they are an exact duplicate of tests standardized in Great Britain and in the U.S.A., as for instance the methods for octane value (C.F.R. Motor Method) Vapour Pressure (Reid), closed flash-point (Pensky-Marten) and others. The determination of octane value is the only engine test in the book. In the case of the measurement of absolute values, such as specific gravity, there is of course but little scope for variation; in the U.S.S.R. when the specific gravity of petroleum products is determined it is converted to density ($d_4^{20}$) which is the standard. It is unfortunate that this should be sufficiently removed from the British standard of S.G. $\frac{60^\circ\ F}{60^\circ\ F}$ to require conversion even for the interpretation of test results, not to speak, of course, of the calculation of oil quantities, whilst yet being sufficiently close to give a misleading impression at a first glance. Now that, at long last, the stoke and poise are giving an international significance to viscosities hitherto hidden behind the empirical nomenclature of Redwood, Saybolt, and Engler, is it too much to hope for that agreement will be reached on a common temperature for density (or specific gravity) measurements, even if the irrational A.P.I. scale further confuses the issue?

Two minor points of interest may be mentioned in connection with the specific gravity methods given in the publication under discussion, the first that a definite viscosity limit of 25° Engler at 50° C (approx 170 cs) is quoted as the limiting value for the determination of specific gravity by a hydrometer, and the other that for oils thicker than this it is permitted to determine the gravity by hydrometer after dilution (1 : 1) with a light kerosine.

Apart from the conventional Engler method, which is stated to be limited to works control and other non-scientific purposes, two methods are given for viscosity determinations, utilizing Ubbelohde U-tubes for the measurement of dynamic viscosity and a modified form of Fenske tube for kinematic viscosity. In the former case provision is made for carrying out the determination under pressure, provided by a small head of water or mercury. A test procedure is laid down for the determination of viscosities at low temperatures (below 0° C). In view of the discussions that have taken place on the choice of a suitable liquid for viscometer calibration, it is of interest to note that the Russian methods allow of a wide choice of chemically pure liquids such as water, formamide, ethylene glycol, aniline, etc., for the calibration of the Ubbelohde viscometer: in the case of the Fenske instrument, however, water is used as the primary standard.

The Russian method for pour point ("setting point") appears to be comparable to that used in Great Britain, being defined as the temperature at which the oil shows no movement during one minute on being examined in a test-tube inclined at an angle of 45°, although the determination of the exact figure appears to be a laborious process, as the oil is heated and re-cooled after every inclination of the tube, which is carried out at specified temperature intervals.

Corrosive sulphur in lubricating oils is determined by the usual type of copper test, the particular choice of time and temperature in this case being 12 hours and 85° C respectively. An oxidation test for transformer oil is laid down, the governing conditions being a duration of 14 hours at a temperature of 140° C in the presence of both iron and copper catalysts and with air blowing. After such oxidation the oil is examined for sludge, acid value, and saponification value. If it is desired

to determine the initial formation of water-soluble acids, this is carried out by a similar test, but at 120° C and for a time of 6 hours.

Among the methods included are some which in Great Britain are not usually to be found in a standard work, being more in the nature of tests carried out in a works control laboratory rather than on finished products; among such determinations are those of the presence of traces of solvent in oils refined by the furfural, nitrobenzol, and phenol processes. The inclusion of tests of this type is perhaps due to the fact that whereas in the U.K. and U.S.A. their choice is left to the individual refiner, the standard methods of test being intended more to ensure that buyers' requirements are determined in a uniform manner, the State operation of all industry in the U.S.S.R. has made it desirable that all producers who are units in a single combine should conform to a uniform works control technique.

The section on the examination of greases is fairly comprehensive, and in addition to the usual physical tests such as penetration, drop point, etc., it includes numerous methods for the chemical examination of greases, the determination of free fatty acids, soaps, rosin, being among the points which are covered. Tests are laid down both for evaluating the protective action of greases in preventing corrosion and also to ensure that the greases themselves are free from corrosive action. In the section dealing with petroleum by-products the traditional Russian interest in sulphonic and naphthenic acids is evinced by the numerous methods for the examination of these materials. Methods are described for the determination of oil, sulphonic acids, and sulphuric acid in "Kontakt," and also for evaluating the fat-hydrolysing activity of this material.

Products dealt with in this section include paraffin wax and bitumen: the setting point of paraffin wax (often referred to as "melting point") is taken as the flat portion of the time–temperature cooling curve. The oil content of paraffin wax is determined by a mechanical expression method. The tests described for bitumen are those usually given in British and American publications, and do not merit any special mention; likewise the description of sampling procedure is conventional.

In general the publication follows the lines that are to be expected in a work of this sort. The majority of the empirical conventional tests of petroleum products appear to follow very closely on British and American practice, which is a commendable feature, since the greater the degree of international agreement on matters such as these, the greater are the facilities for the mutual interpretation of specifications and the interchange of technical information. V. B.

**Dictionnaire Technique des Termes du Pétrole en Français, Anglais, Russe, Allemand.** 2nd edn. Berlin: Groupe Français du Council de Contrôle Mission des Carburants, 1946. Pp. 488.

The first edition of this Glossary of Technical Terms of the Oil Industry was published in French, English, and German in 1937 on the occasion of the second World Petroleum Congress in Paris. It has now been revised and extended to include Russian.

The main glossary of over 3400 terms are arranged in alphabetical order in English, the corresponding terms in the three other languages being given in adjoining columns. Alphabetical indexes in the three other languages are provided. Conversion tables for various weights and measures are included in an appendix.

**British Standard 1312 : 1946. Fuel Fired Regenerative Tank Furnaces for Melting Glass.** London: British Standards Institution, 1946. Pp. 66. 5*s.* post free.

This test code has been framed to cover the testing of regenerative tank furnaces for the melting of glass. Two forms of test are provided: (1) simplified industrial tests for evaluating the performance of furnaces as effective and economic units; and (2) a comprehensive code for complete evaluation of the performance and the efficiency of furnaces.

**British Standard 1316 : 1946. Florescent and Phosphorescent Materials (excluding radio-active materials).** London: British Standards Institution, 1946. Pp. 27. 2*s.* post free.

This specification refers to luminiscent (*i.e.*, fluorescent and phosphorescent) materials in the form of paints, painted panels, plastics, vitreous enamel, etc., for indoor and outdoor use (but not in the form of treated fabrics, armbands, paper, etc.).

**The British Electrical and Allied Industries Research Association Annotated List of Published Reports October 1945.** London: B.E.A.I.R.A., 1946. Pp. 112. 5s. net.

A complete annotated list of reports published by the association, or in co-operation with, the Electrical Research Association. Reports are classified by subject, which include: Geophysics (Properties of the Ground); Insulating Materials (Liquids, Bituminous Filling Compounds, Hydrocarbon Resins, and Waxes); Miscellaneous (Rheology).

**C.S.I.R.—1945.** G. Lightfoot. Melbourne: Government Printer, 1945. Pp. 98.

This report of the Council for Scientific and Industrial Research of the Commonwealth of Australia states that the Lubricants and Bearings Section has developed apparatus and methods for studying the mechanism of boundary lubrication. This work has yielded valuable information and fluids have been developed for such purposes as the drawing and pressing of metals, cutting oils, and extreme pressure lubricants.

**Annual Report of the Research Council of Alberta 1945.** Edmonton: King's Printer, 1946. Pp. 21. 5 cents.

Summarizes the work of the Council during 1945 and deals with investigations concerning bituminous sands, fuels, natural gas, etc. A list of publications is appended.

**Proceedings of the Institution of Mechanical Engineers.** Vol. 153. War Emergency Issues, 1–12, 1945. London: Institution of Mechanical Engineers, 1946. Pp. 517 + xi.

Among the papers included in this first volume of War Emergency Proceedings are: "Controlling Pipe Line Surges," by J. S. Blair; "An Investigation into the Laws of Flow of Fluids through Beds of Granular Materials," by H. E. Rose; "The Isothermal Flow of Gases through Beds of Granular Materials," by H. E. Rose; "On the Resistance Coefficient–Reynolds Number Relationship for Fluid Flow through a Bed of Granular Material," by H. E. Rose; "Combustion in the Gas Turbine," by R. G. Voysey.

**Reports on Fuel Economy since 1939.** U.S. National Committee of World Power Conference. London: World Power Conference, 1946. Pp. 12. 7*d*. post free.

First of a series of reports prepared by National Committees of the W.P.C. on experiences in connexion with fuel economy in their respective countries since 1939 and which will constitute material for the Fuel Economy Conference at the Hague in September 1947. The present report covers the United States and includes 72 references to published literature.

**Handbook of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd.** London: Scientific Instrument Manufacturers' Association of Great Britain, Ltd., 1946. Pp. 48 + 73.

The principal part of this handbook consists of a classified list of scientific instruments indexed in relation to the announcements of various manufacturers contained in the second part of the book. In the foreword the aims and objects of the association are outlined and the growth of the British scientific instrument making industry is reviewed.

## Technical Missions To Germany.

The following reports have been received in addition to those listed on pp. 226 A–230 A and 316 A–318 A:

B.I.O.S. REPORTS.

160. Luftfahrtforschungsanstalt Hermann Göring, Volkenrode, Brunswick. 40 pp.
171. Catalytic Hydrogenation of Acetylene to Ethylene, Dr. Alexander Wacker Ges. für Elektrochemische Industrie, Burghausen. 5 pp.
413. Primary Cells, by Prof. A. Schmid. 4 pp.
474. German Wool-Combing Industry and Wool-Grease Extraction Processes. 57 pp.

531.* German Steel Drum Industry. 110 pp.
534. The Organization of the German Chemical Industry and its Development for War Purposes. 40 pp.
554. Ampoule and Vial making Machines: Improvements and Developments in Germany. 12 pp.
556. H. Walter Kommanditgesellschaft, Kiel (Materials for bi-fuel rockets). 20 pp.
560. Distillation of Phenols at I.G. Farbenfabrik, Wolfen. 5 pp.
562. The German Phosphorus Industry at Bitterfeld and Piesteritz. 52 pp.
572. Investigation into Manufacture and Use of Carbon Blacks and Lamp Blacks in Germany. 120 pp.
577. German Car Industry Special Servicing Equipment for Cars. 7 pp.
582. Interrogation of Dr. Loahfert Rhenania Phosphat Werke, Brunsnuttelkoog, Germany. 8 pp.
585. Aircraft De-Icing at A.V.A., Gottingen. 13 pp.
586.* Ernst Schliemann's Oelwerke Und Export-Cerecin-Fabrik, Hamburg, Germany. 32 pp.
596. Gesellschaft für Teerverwertung Varziner-Strasse, Duisburg-Meiderich, Ruhr. 13 pp.
597.* Interrogation of Dr. C. H. N. Bensmann, October 10, 1945. 3 pp.
598.* Oelwerke Julius Schindler G.m.b.H, Hamburg, Germany. 15 pp.
604. The Shellac Industry in Germany. 17 pp.
612. Klein Schanglin and Becker A.G. Hydraulic Couplings and Torque Converters. 8 pp.
616. Inspection of Krupp-Lurgi Plants for the Carbonization of Coal at Low Temperatures. 41 pp.
621. The Manufacture of Wofatit Base-Exchange Resins. 20 pp.
623. Lurgi Gesellschaft für Warme technik, Frankfurt-am-Main. 14 pp.
626. Drying, Briquetting, and Low-temperature Carbonization of Brown Coal in Lurgi-Spülgas Retorts. 18 pp.
633. Manufacture of Oxalic Acid at I.G. Farbenindustrie, Bitterfeld. 12 pp.
635.* Mineralölwerke Albrecht Lubricants. 22 pp.
636.* Mineralölwerke F. Harmsen Kiel—German Lubricants. 11 pp.
637.* Olex Deutsche Benzin- und Petroleum Gesellschaft: Fuels and Distribution. 13 pp.
638.* Deutsche Erdol A.G., Hamburg, Germany: Crude Oil and Products. 12 pp.
639. Deurag-Nerag Gewerkschaft Deutsche Erdol Raffinerie und Neue Edol Raffinerie: Fuels and Lubricants. 31 pp.
679. I.G. Farben Works at Bitterfeld. Manufacture of Potassium Dichromate and Chromic Oxide. 20 pp.
680. Manufacture of Caustic Soda, Chlorine, and HCl, I.G. Farbenfabrik, Wolfen. 24 pp.
683. Hydrogen Peroxide. Production by Electrolysis of 35 per cent Solutions. Deutsche Gold und Silber Austalt. 26 pp.
711. Interrogation of Dr. Haus-Albrecht Kind of Böhme Fettechemie and Henkel and Cie, Dusseldorf. 78 pp.
713. Notes on Items of Chemical Plant at Works of: I.G. Farbenindustrie, Knapsack; Dr. Alexander Wacker, Burghausen; Anargana, Gendoy; I.G. Farbenindustrie, Hoechst. 15 pp.
715. Microanalytical Methods Employed in the Analytical Laboratories of I.G. Farben., Elberfeld-Wuppertal, Germany. 7 pp.

## C.I.O.S. REPORTS.

XXIII-14. Turbine Engine Activity at Ernst Heinkel A.G. 69 pp.
XXVI-30. Gas Turbine Development by B.M.W. 34 pp.
XXVIII-18. The Universal Faitj System Extraction Process. 3 pp.
XXIX-12. The Production of Tetrahydrofuran Intermediates. 47 pp.
XXIX-12. (Appendix.) Polyurethanes, Dr. O. Bayer (I.G. Farbenind., Leverkusen). 21 pp.
XXXII-17.* Underground Factories in Central Germany. 154 pp.
XXXII-52.* Gas Utilities in Germany. 34 pp.
XXXII-56. Pyrotechnic Anti-pathfinder Devices. 36 pp.

XXXII–58. The Chemical Compositions of German Pyrotechnic Smoke Signals. 6 pp.
XXXII–68.* The Manufacture and Application of Lubricants in Germany. 46 pp.
XXXII–124. Items Selected from the Minutes of the Meetings of the I.G. Technische Ausschuss. 5 pp.
XXXIII–37. Coke-Oven Installation of Reich-Werke A. G. Hermann Göring Werke at Watenstedt near Brunswick. 32 pp.
XXXIII–40. Nordstern Coke-Oven Plant Gelsenkirchner Bergwerks A.G. 5 pp.

## F.I.A.T. REPORTS.

8. Investigation of Textiles, I.G. Farbenindustrie, Bobingen. 9 pp.
67. Chemical Developments and Applications in the Synthetics Industry of Germany. 69 pp.
93.* Interrogation of Professor Franz Fischer. 3 pp.
183. Reinhold and Co. G.m.b.H., Frankfurt A.M. Sued. 3 pp.
213. Summary of Field Investigations: Fats, Oils, and Oilseeds. 25 pp.
239.* Fischer–Tropsch Plant of Hoesch Benzin A.G., Dortmund, Germany. 3 pp.
261. Gas Compressors Manufactured by Griederic Uhde K.G., Dortmund, Germany. 6 pp.
273. Interview with Dr. J. W. Reppe, I.G. Farbenindustrie A.G. 20 pp.
292. The Manufacture of Laboratory Apparatus, Instruments, and Equipment. 15 pp.
293. I.G. Farbenindustrie, Leverkusen, Germany. 11 pp.
297. Fats, Oils and Oilseeds. 23 pp.
362. Synthetic Fatty Acids I.G. Farbenindustrie A.G., Ludwigshafen. 3 pp.
364. German Fats, Oils, and Oilseed Processing Plants. 19 pp.
365. Industrial Proteins Karl Freudenberg A.G. 5 pp.
388. Counting Devices Germany. 9 pp.
423. Synthetic Lubricating Oil Manufacture, Rhenania-Ossag Mineralowerke A.G. Harburg Refinery. 6 pp.
429. Development Work for Manufacture of Caustic Soda and Sulfuric acid from Sodium Sulfate. 5 pp.
447.* Study of Production of Shale Oil from Shale in Wurtenberg. 98 pp.
464. Survey of German Coated Fabrics Industry. 20 pp.
489. Survey of Fans and Turbo Blowers. 51 pp.
511. Acetylene Generator Designs in Germany, 1945. 22 pp.
528. Light Sensitive Reproduction Materials. 89 pp.
546. Wool Scouring, Wool Grease Recovery and other By-Products Recovery. 10 pp.
577. Survey of the Leading Manufacturers of Pressure Vessels. 52 pp.
612. Carburettors for Automobiles as Produced in Germany. 12 pp.
624. Robert Bosch Development of a Low Tension Spark Plug (System "Smits"), Robert Bosch A.G., Stuttgart. 6 pp.
645. The Dyeing of Spun Rayon and Rayon Filament Yarn in Mechanical Apparatus in Germany. 7 pp.
678. German Scientific Literature Published During the War. 120 pp.
681. The Paint, Varnish and Lacquer Industry of Germany. 64 pp.
685. Ferdinand Porsche—10 Cylinder Vee-Type Air-Cooled 300 H.P. Gasoline Engine. 5 pp.
704. Final Summary of the Sub-Committee for Shipbuilding in Germany. 16 pp.
712. Manufacturing Process for Desmodur R. 8 pp.
737.* Economic Study of German Synthetic Waxes. 32 pp.
741.* Catalysts for Coal Hydrogenation. 4 pp.
810.* Activated Clay Bleaching Adsorbents. 20 pp.

## J.I.O.A. REPORTS.

11. German Military Water Supply Equipment (Research and Development). 30 pp.
40.* German Oil Refineries. 98 pp.
45. Industrial Safety in Germany. 150 pp.

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# Oilfield Exploration and Exploitation.

## Geology.

**1323. Piercement Trap Reservoirs.** O. Wilhelm. *Oil Gas J.*, 27.4.46, **44** (51), 147.—Piercing masses usually tilt and fault the beds penetrated. Piercement is commonly due to salt masses, igneous plugs, and the plastic cores of anticlines. Associated with salt masses there may be crescent, salt niche, peripheral wedge, peripheral segment, and composite reservoirs.

A diapiric anticline is one in which the plastic core has pierced the other beds. The structure may be complex. G. D. H.

**1324. What is the Geological Fence?** Anon. *Oil Gas J.*, 1.6.46, **45** (4), 113.—The geological fence defines the conditions which must be fulfilled by any acceptable theory of oil origin. The geological evidence in favour of *organic origin* is almost overwhelming. 99% of the oilfields are in marine sediments, and 1% in brackish sediments, indicating a *marine environment* of formation. The *temperature of formation* must not substantially exceed 212° F, and static *pressures* must not exceed 5000 p.s.i., thickness of sediments and other evidence pointing to these limits. Oil has not been found in sediments younger than the Pliocene, suggesting an age of about a million years for the youngest known oil. G. D. H.

**1325. Calculation of the Petroliferous Reserves of a Geological Layer.** A. Lugaresi. *Riv. Ital. Petrol.*, 1946, **14** (160), 9.—The quantity of petroleum which can be extracted from a given layer varies with the porosity and permeability of the stratum, with the degree of impregnation of the rock, with the viscosity of the oil, with the presence or absence of water and gas, and with the texture and structure of the formation. Some of these expressions are quantitatively defined. The work of Cutler, Bradford, and others in the U.S.A. (Bureau of Mines) is summarized and examined. It is concluded that displacement of oil by gas raises the yield to 50 to 65% when the field is nearing exhaustion, and to 70 to 80% if gas displacement is introduced when exploitation begins. D. H. McL.

**1326. Two Promising Tests Revive Interest in Florida Wildcatting.** H. David. *Oil Gas J.*, 1.6.46, **45** (4), 50.—O. D. Robinson State on Barnes Sound, Monroe County, first encountered oil-shows in the Lower Cretaceous at 10,162 ft, and had numerous saturated zones down to 10,365 ft. The upper part had the best saturation, the lower part consisting of tight limestones. After drilling to 12,050 ft the well was plugged back and perforated at 10,337–10,363 ft and acidized. Swabbing yielded a little heavy black oil.

1 Cory, also in Monroe County, found the top of the Lower Cretaceous at 8168 ft, while the Barnes Sound test met it at 6997 ft. The Key Vaca test stopped in the Eocene Oldsmar limestone, with the top of the Lower Cretaceous expected at about 8000 ft.

1 Hernasco Corp. had an oil show in cuttings at 5595–5600 ft, the Cretaceous having been entered at 3340 ft. A drillstem test at 5585–5605 ft recovered only salt water and mud.

The Upper Cretaceous beds overlap a thick wedge of Lower Cretaceous. 5000 ft or more of Lower Cretaceous occurs at Sunniland.

The main structural feature in Florida is a gentle doming. At the base of the Upper Eocene Ocala limestone is an unconformity. Hence the underlying structures may be stronger. 125 wells, mostly shallow, have been drilled in Florida. Until 1939 no well exceeded 6000 ft in depth, and few reached 3000 ft. Three oil wells have been completed in the Sunniland field which produces from a Lower Cretaceous limestone at 11,500–12,000 ft. The oil is 20–25° A.P.I. gravity.

A well 80 ml southwest of the Barnes Sound test has reached 7640 ft, and penetrated the Pliocene, Miocene and Oligocene in the first thousand feet. G. D. H.

**1327. The Anadarko Basin—Will it Pay Off?** C. N. Gould. *Oil Wkly*, 8.7.46, **122** (6), 61.—Oil and gas have been known in the Anadarko Basin for more than 40 years. In 1901 primitive wells were being operated a few miles northwest of Granite, Oklahoma. The Gotebo field was opened in 1908, the Cement field in 1916, and the Sayre field in 1922.

The Anadarko Basin was first officially labelled in 1924. Its structure is similar to that of the basins in Illinois, Michigan, Texas, and other states where important fields have been found. Its rock types appear to be favourable, and it is almost surrounded by producing areas.

Many believe that the Ardmore Basin south of the Arbuckles is continuous with the south end of the Anadarko Basin. The position of the west end of the Anadarko Basin is still undetermined, and the site of its northern margin is still not known with certainty. It may extend as far as the Kansas border in the north, and have western branches into Kansas and New Mexico. G. D. H.

**1328. Industry Finds Many New Fields.** Anon. *Oil Wkly*, 29.7.46, **122** (9), 71.—In the first half of 1946, 213 new fields were opened in U.S.A. This compares with an average of 171 per half year for the years 1937–1945. This year's discoveries included 146 oilfields, 16 distillate fields, and 51 gas-fields. The 1946 discoveries may have given over 1000 million barrels of reserves. The production in the first half of 1946 was less than this figure.

During the nine-year period 1937–1945 2423 new oilfields were found in U.S.A., and the average reserve provided per discovery was 8,493,029 brl. Using this figure as a yardstick, the discoveries in the first half of 1946 should provide 1,239,981,000 brl of new oil. Production in the first half of 1946 was 846,638,000 brl. Unless current discoveries are much poorer than in the past it is unlikely that reserves have suffered a net decline.

13·4% of all wells drilled in the first half of 1946 were wildcats; the figure for the 1937–1945 period was 11·4%. 11·7% of this year's wildcats were successful; the over-all success figure for the period 1937–1945 was 11·1%.

A table gives the ratio of wildcatting to all drilling and the proportion of all wildcats discovering new fields, by districts for the period 1937–1946. G. D. H.

**1329. Wildcatting Keeps Pace with Record 1945 Total.** Anon. *Oil Wkly*, 30.9.46, **123** (5), 31.—During the first eight months of 1946, 2904 exploratory wells have been completed in U.S.A. The corresponding figure for 1945 was 2905. 594 of the 1946 tests have been successful. 328 of them opened new oil-sources, 194 being new fields and 134 being new pay horizons. There were 44 new distillate discoveries and 113 new gas discoveries. 434 exploratory wells were completed during August. California had three oilfield discoveries during August, two being promising fields near Los Angeles. Colorado's Rangely field was extended. Five new oilfields were discovered in Illinois. Texas discoveries in August included 16 new oilfields, two distillate fields, two gas-fields, 10 new oil-pays, and two new distillate pays.

Tables summarize the results of exploratory completions during August and during the first eight months of 1946 by States and Districts. The August discoveries are listed with brief notes. G. D. H.

**1330. Socony-Vacuum is Testing Wildcat Well in Colombia.** Anon. *Oil Wkly*, 8.7.46, **122** (6), 30.—Yanacue 1 in the Magdalena valley is being tested. It lies west of the Cantagallo field. Pedro 1, across the river east of the Cantagallo field, is fishing at 9310 ft. La Salina 1 is drilling below 2888 ft. G. D. H.

**1331. Texas Petroleum's Well in Colombia at 7923 ft.** Anon. *Oil Wkly*, 8.7.46, **122** (6), 30.—Velasquez 1 in the Upper Magdalena valley has reached 7923 ft. Drill-stem tests have given oil shows, 35-gravity oil having been found at 7254–7274 ft, and there were shows at two higher levels. One section of 350 ft is reported to have had 162 ft of net oil-sand. G. D. H.

**1332. Phillips' Wild Well in Venezuela under Control.** Anon. *Oil Gas J.*, 18.5.46, **45** (2), 94.—Phillips' wild well is reported to have been flowing 50,000,000 cu. ft. of gas and several hundred barrels/day of oil. This well, in Monagas, is near and in the trend of the Jusepin-Santa Barbara fields. Gas was found at 4581 ft, and the first oil sand at 4706 ft. It is estimated that 375 ft of gas- and oil-saturated sands occur in a 600-ft section. The oil gravity ranges 25–35° A.P.I. G. D. H.

**1333. Dual Completion from Eocene Sands Possible in Amana Area, Venezuela.** Anon. *Oil Wkly*, 2.9.46, **123** (1), 48 (International Section).—Amana 3 has been drilled to 5300 ft. Tests through perforations have been made in the Eocene sands in the interval 3175–4000 ft. A sand at 3110–3255 ft, identified as the Mostrencas, has supplied 200 brl/day of 31-gravity crude. Perforations are expected to be made in the interval 3275–3955 ft, in order to give a dual producer. It is expected that a deep Cretaceous limestone test will be drilled. The structure is anticlinal with no apparent major faulting, and it lies 18 ml northwest of the Mara field and about 20 ml north of La Paz. G. D. H.

**1334. Second Tierra del Fuego Well down to 8500 ft.** Anon. *Oil Gas J.*, 15.6.46, **45** (6), 83.—A well 800 m. northeast of the Tierra de Fuego discovery well has reached 8500 ft. Oil was found at the 7500-ft level in the discovery well. G. D. H.

**1335. French Research Emphasizes Oil Exploration and Utilization of Petroleum Gas.** P. Guillaumat. *Oil Gas J.*, 27.4.46, **44** (51), 98.—The Saint-Marcet structure is being explored and developed, and tests are being undertaken on the nearby structures at Aurignac, Genesac, Proupiary, Plagne, and Saint-Martory. Ten gas-wells and two dry holes have been completed at Saint-Marcet. Two of the wells flowed some oil, and others had indications of light oil. To the beginning of 1946 the cumulative production of gas was 5,250,000,000 cu. ft, with 21,000 brl of oil and 2,860,000 lb of butane.

The first well at Plagne went to 6557 ft. It has gas shows in several shallow sands. A second test has reached 3960 ft, and had a gas-saturated sand at 328 ft. Three disappointing wells have been drilled at Genesac, the deepest being 10,197 ft. A 9818-ft test was drilled at Aurignac. Gas was encountered in a breccia in a 7597-ft well on the Proupiary structure, which is connected with Saint-Marcet. Seven shallow tests have been made at Saint-Martory, and a deep test is under way.

A well has been drilled on the structure at Dreuille, going to 6758 ft without success. A second well has reached 5280 ft. Two wells are being drilled at Tresiers, and are over 3500 ft deep. 15 shallow tests have been drilled around Tresiers, Cax and Auch.

At Gardiole a well is drilling at 2379 ft, and one at Vaunage has reached 1476 ft. Several shallow wells have been drilled at Gabian and Saint-Chinian.

The rock pressure at Saint-Marcet is about 2410 lb/sq. in. G. D. H.

**1336. Oil Prospecting and Natural Gas Utilization in the South of France (1) Marceau.** *Petroleum*, Aug. 1946, **8** (9), 180.—The utilization of natural gas and the exploration of more recently discovered oilfields in the South of France is discussed. K. C. G. K.

**1337. Oil Prospecting and Natural Gas Utilization in the South of France. (2) Marceau.** *Petroleum*, 1946, **9** (9), 217.—Details are given of the treatment and utilization of natural gas by the Régie Autonome des Pétroles (R.A.P.). A number of experimental borings within recent years are mentioned. K. C. G. K.

**1338. Kirkleatham Wildcatting Test in Yorkshire is Abandoned.** Anon. *Oil Wkly*, 2.9.46, **123** (1), 48. (International Section).—Kirkleatham 2 has been abandoned

in the Carboniferous at 3091 ft. Gas was encountered in the Upper Permian limestone as in Kirkleatham 1, but low porosity and permeability caused production to be smaller. G. D. H.

**1339. Hungary Gas Drilling in Vicinity of Karcag.** Anon. *Oil Wkly*, 15.7.46, **122** (7), 31.—Drilling for gas is proceeding at Karcag, east of the Tisza, where there are surface shows. G. D. H.

**1340. Hungary Reports New Oil and Gas Deposits.** Anon. *Oil Wkly*, 30.9.46, **123** (5), 15.—Several new oil and natural gas accumulations are reported to have been found east of the Danube. G. D. H.

**1341. Russia's Search for Petroleum.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (160), 13.—A survey of Russia's actual and potential sources of petroleum. D. H. McL.

**1342. Search for Oil in Spain to be Greatly Accelerated.** Anon. *Oil Wkly*, 30.9.46, **123** (5), 15.—Current oil prospecting in Spain is centred around Burgos and Soria north of Madrid. During the past year a well has been cored to about 2000 ft, without having encountered encouraging oil-shows. G. D. H.

**1343. French Equatorial Africa Oil Possibilities said Good.** Anon. *Oil Wkly*, 15.7.46, **122** (7), 31.—Geological studies in the province of Gabon have been completed, and it is thought that oil exploitation in the region of Azinga might be successful. G. D. H.

**1344. Deep Tests being Planned for North Tunisia Section.** Anon. *Oil Wkly*, 22.7.46, **122** (8), 15.—A wildcat is being drilled at Zaouia, 5 ml southeast of Hadjebel-Aioun. Earlier tests, said to have had gas shows, southwest of Bizerta and south of Ferryville, were abandoned at 2500 ft and 7500 ft in 1936 and 1940, respectively. Further tests are projected north of Souk-el-arba (northern Tunisia) and near Tebaga (southern Tunisia). G. D. H.

**1345. Wildcat on Sinai Peninsula Shows for 275 brl Daily.** Anon. *Oil Gas J.*, 18.5.46, **45** (2), 97.—The S.U.D.R. wildcat on the east coast of the Sinai Peninsula is reported to have a potential of 275 brl/day of 22° A.P.I. oil from the interval 2680–2925 ft. G. D. H.

**1346. N.E.I. Oil Awaits Settlement of Post-war Political Problems.** Anon. *Oil Gas J.*, 18.5.46, **45** (2), 95.—108,000,000 brl of oil has been produced from some dozen fields in Java. The structures are mainly moderately steep asymmetrical anticlines, commonly intersected by faults. The oil comes from Upper Miocene sandstones at depths of 700–3000 ft.

The core of Java is geanticlinal, but has only small exposures of pre-Tertiary beds. In western Java there are 9500–10,500 ft of Tertiary beds which are mainly marine except near the top. Much of the area is covered unconformable by Plio-Pleistocene beds. There are surface oil shows. In eastern Java the known section amounts to 10,200–12,000 ft, but may be much thicker. There are very few porous beds. Sands are rare except high in the section. Limestones also are limited. Stratigraphic trap possibilities have not been examined.

The Balikpapan area of Borneo has produced about 240,000,000 brl of crude. Nearly all the producing structures are on a single anticlinal trend. They are moderately strong, with cross-faulting and steep western flanks. The oil is in Upper Miocene and Pliocene sands. About ten different sands produce down to 2500 ft. The oils are less asphaltic with depth.

The fields of the Tarakan area have given 144,000,000 brl of oil from Pliocene and Upper Miocene sands. The main field, Pamoesian, has 15 sands down to 3700 ft.

100,000,000 brl of oil has come from the Miri-Seria area. Miri is almost depleted, and is a rather complex highly faulted asymmetrical fold, with thrusting on the south-east flank. The axis of the east-west Seria fold lies off-shore. There are steep dips

on the south flank. Production comes from the Upper Miocene. Eocene production is obtained from the structures in the Barito area.

In Eocene and Oligocene times thick deposits of sediments and volcanics were formed in west central and southeast Borneo, and marine shales, limestones and sandstones in central and east Borneo. In the Lower Miocene there are interbedded marine and freshwater beds, the latter increasing upwards to the Pliocene which is almost entirely terrestrial. Earth movements began in the late Miocene forming three embayments in which deposition continued. There was steep folding in the central parts of the basins.

The Vogelkop basin has a thick Tertiary section with numerous structures, and there are oil indications. Oil has been found on the Klamono, Wasian and Mogoi structures. Klamono has 8 producing wells proving 400 acres. It is a broad faulted anticline with oil in a limestone at 300 ft on the crest. The saturated sections are up to 400 ft thick. Wasian has two oil wells in a Miocene limestone. Mogoi has one well in the Miocene limestone. Both Wasian and Mogoi are gentle structures.

The Boela field of eastern Ceram gives oil from Plio-Pleistocene sands at 200–1000 ft. G. D. H.

**1347. Says Delhi Field Biggest of Type Since East Texas.** Anon. *Oil Wkly*, 15.7.46, **122** (7), 30.—The discovery well at Delhi was completed in December 1944, giving 108 brl/day of 41-gravity oil. 219 additional wells have been drilled, and the production is 16,000 brl/day. The reserves are estimated to total 175,000,000 brl. The field is a stratigraphic trap, and produces from the Tuscaloosa and Paluxy.
G. D. H.

## Geophysics and Geochemical Prospecting.

**1348. Validity of Data from Airborne Magnetometer.** H. Jensen. *World Petrol.*, 1946, **17** (9), 45.—The conventional geological magnetometer was developed for mobile use in submarine work. The modified form has been used for aerial geological survey with the advantages, *inter alia*, of providing a continuous record and reducing errors due to local magnetic bodies. Position control has been carried out photographically and with the aid of electronic devices. F. S. A.

**1349. The Electronic Principle Employed for the Discovery of Petroleum.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (160), 15.—The instrument devised by Craver of the Massachussets Institute of Technology for the discovery of petroleum is described. The instrument (known as the Petromer) is capable of defining several characteristics of a petroliferous layer, and its scope is defined in this description. D. H. McL.

**1350. Application of Mud Analysis Logging.** R. E. Souther. *Geophysics*, 1946, **10**, 76–90.—The mud analysis logging system, now widely used for exploratory and routine drilling, continuously analyses and records the oil and gas content of mud returns from wells being drilled by the rotary method. Oil and gas detected in the returning drilling fluid indicates oil or gas in the formation penetrated by the bit. Results of the continuous analyses are instrumentally correlated to the depths and formations from which the showings originated. A second useful phase of the system plots accurately and in detail rate of penetration or drilling speed on the log as a function of depth.

Trucks and trailers provide a mobile housing for all the mud analysis equipment so that it may be moved rapidly from well to well.

Applications of the method may be divided into two classes:

1. Routine drilling in proved areas where it eliminates unnecessary coring and locates gas caps and completion zones.

2. Exploratory drilling in which it minimizes coring by indicating for testing purposes porous zones containing oil and/or gas.

Mud analysis logging can be practised in areas where the electrical log cannot be used due to high salt content or other local conditions, where dangerous hole conditions make interruption of drilling operations for coring inadvisable, and for evaluating gas zones where cores are difficult to interpret.

In addition, each mud analysis logging unit contains equipment to obtain informa-

tion useful in eliminating washouts, in predicting and preventing blowouts, and in controlling drilling mud characteristics. E. I. R.

**1351. Exploring the Continental Shelf.** C. J. Deegan. *Oil Gas J.*, 15.6.46, **45** (6), 98.—The commonest geophysical devices for underwater investigations are the gravity meter for reconnaissance and the seismograph for detail. The latter could be used in 600 ft of water, although the work would be expensive. Two general types of diving bells are in use for gravity meter work. One is suitable for depths up to 40 ft, the other up to 250 ft. In shallow water 25 stations/day and in deep water 10 stations/day can be covered with diving bells.

A series of diagrams and photographs show the construction and operation of the two types of diving bell. G. D. H.

**1352. Early Reflection Seismograph Exploration in California.** H. Salvatori. *Geophysics*, 1946, **10**, 17–33.—Following the success achieved in Oklahoma, a major attempt was made in 1931 to use the reflection method of seismic prospecting in California. The records obtained were exceedingly poor, and the results of this early work very disappointing. This was due to the fact that the area chosen was particularly unfavourable for reflection prospecting, and would give poor results even if modern technique and equipment were used. However, in 1932 a prospect near Merced was successfully mapped. The dip method of shooting became standard practice, as the correlation method so successful in Oklahoma was generally unsatisfactory in California. Wide spacing of lines and stations was the rule, as only structures having large amounts of closure were considered important. As a result of this early reflection work several important oilfields, including the Wilmington and Rio Bravo fields, were discovered. A brief history of the discovery of these two fields is given, and the seismic maps are compared with those compiled from well data. E. I. R.

**1353. History of the Geophysical Exploration of the Cameron Meadows Dome, Cameron Parish, Louisiana.** G. M. McGuckin. *Geophysics*, 1945, **10**, 1–16.—The development of the gravitational and seismic methods of geophysical prospecting since 1926 is discussed with reference to a typical Gulf Coast salt-dome. This dome lies entirely within the Cameron marsh area, and airplane photographs reveal no physiographic expression. The following methods were used: mechanical refraction seismograph (1926), torsion balance (1927), electrical refraction seismograph (1928–29), early correlation reflection seismograph (1929), dip reflection seismograph (1933), special salt profiling refraction seismograph (1942), continuous correlation reflection seismograph (1942), gravity meter (1943). The torsion balance revealed a significant gravity minimum indicating deep salt, and this was confirmed by subsequent drilling and later geophysical surveys. The additional structural details revealed by the later surveys is particularly striking. E. I. R.

**1354. Gravimeter Prospecting for Chromite in Cuba.** S. Hammer, L. L. Mettleton and W. K. Hastings. *Geophysics*, 1945, **10**, 34–49.—Early in 1942 the Gulf Research and Development Co. carried out a gravimeter survey in the chromite bearing Camaguey district of Cuba. As a result of this work one large chromite orebody was located. This paper is of general interest owing to the fact that gravity anomalies as small as 0·05 milligal were considered to be of economic importance, thus taxing the limiting performance of modern gravimeters. E. I. R.

**1355. German War-time Developments in Geophysical Instruments.** Anon. *Petrol. Times*, 31.8.46, **50** (1281), 908.—A summary of the BIOS Report No. 334 by Professor A. O. Rankine. The most important developments were in the field of gravity surveying (with the invention by Dr. Graf of a new gravimeter) and in methods of recording the results of geophysical work. The new Graf gravimeter is a better instrument than the Thyssen, which was used in Germany before the war, but it is inferior to the best of the American gravimeters, such as the Gulf and the La Coste. No great progress has been made in the fields of seismic, electrical, and magnetic prospecting, and in no case are the new German instruments greatly, if at all, superior to the British or American types. R. B. S.

## Drilling.

**1356. Deeper Drilling Necessitates that Greater Emphasis be Placed on Drill-Pipe Testing.** G. Weber. *Oil Gas J.*, 31.8.46, **45** (17), 72.—A general study of drill-pipe inspection is presented. Magnetic particle inspection and the fluorescent penetrant method are cited as aids to visual inspection, together with automatic testing methods which would indicate defects to be further inspected by skilled personnel. The latter methods involve techniques based on a number of principles, including surface magnetic field measurement, diffraction or back reflection of gamma rays and X-rays, hysteresis and eddy current losses, and conduction of heat, electric currents, vibrations, supersonic waves, X-rays, and other radiations. The different grades of pipes are described and some of present-day and prospective field inspection methods are discussed.

A. H. N.

**1357. Mud Engineering in Modern Drilling Practice.** Anon. *World Petrol.*, 1946, **17** (9), 46–49.—The paper consists of a review of the desirable properties of drilling muds and methods by which such properties can be most nearly obtained. Special reference is made to the sodium salt of carboxymethylcellulose as a mud component. A non-critical comparison between water base and oil base muds is drawn. F. S. A.

## Production.

**1358. Gas Recovery Systems.** D. Rogers. *Producers' Monthly*, June 1946, **10** (8), 54.—(*Paper presented at annual meeting Eastern District Division of Production, A.P.I.*, Pittsburg, June 1946.)—In this paper gas recovery refers to the salvage of solution gas escaping from produced crude oil either at low pressure or under vacuum. The amount of gas which can be recovered from a barrel of produced crude oil depends on the gravity and temperature of the oil and the pressures under which it is handled. Gas recovery in the Bradford field is effected at the gas–oil–water separators and stock-tanks. The gas-recovery line takes gas from the separator dome and from the top of the stock-tanks, and delivers it either directly to a vacuum pump or to a vacuum gathering system. Some companies use separators in which the oil and water levels automatically adjust the outlet flow by float-operated valves. "Slop" tanks are often used to perform a secondary oil-water separation, and thus reduce losses caused by emulsions, stuck-valves, freeze-ups, and excessive fluctuations in fluid flow. Another type of installation uses a gasometer to regulate the pressure.

The economics of gas recovery is briefly studied: it appears that by carefully analyzing all pertinent factors an oil-producer can determine whether gas recovery will be profitable on his properties, how much initial investment will be required, and how soon a pay-out can be expected.

The paper is well illustrated by diagrams and seven references are appended.

R. B. S.

**1359. Control of Gas-Cap Expansion.** W. J. Travers, Jr. *Oil Gas J.*, 20.7.46, **45** (11), 91.—*Paper presented before A.P.I.*—The field structure and conditions in a deep California field are discussed. A study of the history of production of the field reveals an expanding gas-cap resulting in increasing gas–oil ratios. The first method of gas–oil ratio control consisted of shutting in wells where ratios had climbed above 2000 cu. ft./brl. By April 1942 six wells were shut in for this reason. It was then apparent that some means of gas–oil ratio control which would avoid the loss of producing wells would be necessary efficiently to carry out the objectives of pressure maintenance. A plan was worked out for a remedial programme so that by cementing sections of the well the gas–oil ratio could be reduced. This plan is described in detail, together with the improvements attendant on its execution. A. H. N.

**1360. Plastic Plugging Reduces Gas–Oil Ratios.** E. S. Bauer. *Oil Gas J.*, 31.8.46, **45** (17), 88–89.—Plastic plugging is an effective and at the same time economical method of sealing off unwanted water and gas intrusion into oil-pays. Extensive work done in the west Texas oilfields, using Resinox (a phenolic, low-temperature curing resin), has proved that effective control of gas–oil and water–oil ratios can be

gained within a price range economically practical to oil producers. The highly acid gases prevalent in the oilfields will not dissolve the plastics to cause new fissures. Plastic plugging is less expensive than tamping lead filaments and turnings into wells and, unlike this method, a well that has been plugged with plastics, be it a gas-shut-off, a bottom-hole-water shut-off, or a mid-section water shut-off, can be easily drilled deeper at a later date. A method of plugging used is described which can be used to reduce either water or gas produced with the oil. A. H. N.

**1361. Operators in Hull and Silk Field Study Repressuring Programme.** C. H. Keplinger and J. M. Wanenmacher. *Oil Gas J.*, 31.8.46, **45** (17), 76.—A detailed report on the geology, structure, and past development of the Hull and Silk Field is presented as an introduction to the necessity of instituting a re-pressuring programme for the field. The field is under the control of several operators, and the project calls for a unitized repressuring scheme. Estimates of reserves and profits are given. A. H. N.

**1362. East Texas Field Has Record of Outstanding Results from Its Four Year Programme of Salt Water Disposal.** Part 4. W. S. Morris. *Oil Gas J.*, 31.8.46, **45** (17), 92.—Effects of injection of salt water into East Texas Field on the production economics of the field by maintaining the reservoir pressure are studied with the aid of a tabular and graphical representation of the results so far achieved. A. H. N.

**1363. Source and Purification of Water Supply.** G. W. Holbrook and A. R. Ellenferger. *Producers' Monthly*, June 1946, **10** (8), 57. (*Paper presented at annual meeting Eastern District Division of Production, A.P.I.*, Pittsburgh, June 1946.)—The importance of adequate quantities of water of proper quality for water-flooding operations is stressed. The selection of the most suitable source and the methods to obtain the required amounts is one problem, and the determination of the proper treatment to make the water most suitable for use is another.

The better the quality of the raw water to start with, the less treatment is required. Surface waters from lakes and rivers often vary in quantity and quality with changes of season. They usually contain substantial quantities of mechanical impurities such as mud, sand, suspended clay, and organic matter, and frequently require extensive settling basins with adequate clean-out provisions, in addition to filters. The changing quality is an even greater disadvantage, for it calls for continuous close supervision of the treatment process, and changes in the treatment to match changes in the quality. Springs provide water relatively free from mechanical impurities and less likely to be affected by changes of season, and they eliminate the necessity of underground equipment to make the supply available. Unfortunately the quantity available is seldom adequate for water-flooding work. For these reasons the majority of water-floods in operation at the present time are supplied by sub-surface waters obtained through wells from porous formations. The available quantity of such a water supply is in most cases limited only by the number of wells drilled, and the quality will ordinarily change only very slowly with time.

The primary purpose of water treatment is to maintain the highest rate of recovery and to get the greatest economic recovery of crude from the development, by preventing any unintentional plugging of the sand at the input well which would cause a decrease in the input water rate. A second purpose is to prevent corrosion, not only to save maintenance expenses, but also because the products of corrosion themselves cause plugging of the sand face. A third purpose is to increase the efficiency of displacement of oil by water. Among the various impurities the most important are suspended matter, microscopic organisms, dissolved gases, and various dissolved solids; the acidity (pH valve) also has an important effect. There is no standard water treatment which will remove all the impurities which may be present, and proper treatment must be devised in each individual case on the basis of water analyses. Improper treatment can result in a water much more harmful than the original raw water, particularly insofar as chemical plugging may occur.

The various treatments commonly used are aeration, chemical treatment, settling, algae treatment, filtering, and de-aeration. Aeration increases the oxygen content, but causes precipitation of iron and manganese as oxidized products, and also removes carbon dioxide and hydrogen sulphide. Alkalis are used to raise the pH value and

remove carbon dioxide. Chlorine controls algae and assists in the oxidation of iron and manganese. Polyphosphates are used to stabilize water by holding in solution the carbonates present and also for preventing corrosion by the deposition of a thin protective coating. Sodium sulphite can be used for oxygen removal and alum is sometimes used as a coagulent to improve the efficiency of filters. Ample time and capacity for settling must be allowed for and adequate provisions must be provided for cleaning out settling-tanks. Hypochlorites, copper sulphate, and phenol derivatives are effective in removing algae. Vacuum treatment can be used for de-aeration. Finally, the various types of filtering treatments are discussed. R. B. S.

**1364. Water Meters (to measure input of water intake wells).** F. Milne. *Producers' Monthly*, June 1946, **10** (8), 51.—The measurement and control of water intake in water-flooding are essential for the scientific control of these operations. The basic rules governing the installation of a high-pressure water-meter on an intake well are: (1) after the meter is installed turn the water on slowly and allow the water line, the well, and the meter to be thoroughly filled; (2) open the air-vent screw on the meter about three turns to allow any air to escape that might be in the meter; and (3) open the valve on the water-line gradually after the pressure is built up in the well. The meter cannot then race at an excessive rate, because the pressure will be nearer equal on both the inlet and the outlet of the meter.

Care must be used that silt, rust or scale are not allowed to enter the meter, and the water used must be free from chemicals or acids which would have a damaging effect on the finely machined surfaces of bronze and hard rubber parts within the meter. These things not only result in inaccurate registration, but eventually cause premature wear and damage. Many producers use a 1-inch-high pressure-strainer ahead of the meter and installed so that it can be removed for cleaning. In view of the rate of water-flow through a meter the possibility of freezing up is remote, however; enclosed oil-gear trains are to be preferred to open wash-gear trains in this respect.

The various types of water-meters suitable for oilfield use are briefly described. R. B. S.

## Oilfield Development.

**1365. Exploratory Drilling Rate Down, Success Ratio Up.** Anon. *Oil Wkly*, 29.7.46, **122** (9), 75.—2097 exploratory tests were completed in U.S.A. during the first half of 1946. 21·7% of them were successful. In the corresponding period of 1945 18·8% of the exploratory wells were successful. This year there have been 347 discoveries and 109 extensions.

California, New Mexico, and the Rocky Mountain States have had fewer exploratory completions than in 1945. Illinois had five new oilfields, five new pays, and five extensions in June; Kansas had four new oilfields, a gas-field and two extensions; Oklahoma had six new oilfields, one gas-field, a new oil-pay, three oilfield extensions, and a gas extension; and Texas had eight new oilfields, four gas-fields, five new oil-pays, two new gas-pays, one distillate pay, and three oilfield extensions.

Tables give a summary of the exploratory drilling results, and details, by States, of the exploratory drilling results for June and for the first half of 1946. The June discoveries are listed with a brief statement of the salient points. G. D. H.

**1366. Completions May top 1945 Total.** Anon. *Oil Wkly*, 29.7.46, **122** (9), 58.—13,568 wells were completed in U.S.A. during the first half of 1946, compared with 12,172 in the corresponding period of 1945. Increases over 1945 were shown in Texas, Colorado, Oklahoma, Kansas, Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and New York.

2392 wells were completed in June, 1946, 1297 finding oil and 211 finding gas.

A table summarizes the U.S.A. well completion results for June and for the first half of 1946, by States and districts. G. D. H.

**1367. Footage Being Drilled at Pre-War Rates.** Anon. *Oil Wkly*, 29.7.46, **122** (9), 86.—In the first half of 1946 a total of 45,848,047 ft of hole was drilled in the 13,568 U.S. completions. The corresponding figures for 1945 were 43,249,271 ft and 11,911 new wells.

On the Louisiana Gulf Coast the average depth of completions in the first half of 1946 was 9064 ft. Florida's 11 completions averaged 7083 ft per well.

Tables give the numbers of completions, total footage, and average footage per well yearly from 1925, and similar data, by States, for the first halves of 1941, 1945, and 1946. G. D. H.

**1368. Independants Drill Three-Fourths of Wells.** Anon. *Oil Wkly*, 29.7.46, **122** (9), 59.—During the first half of 1946 10,125 wells in U.S.A. were completed by the smaller companies and independents. 3163 wells were completed by the remaining companies. The former groups completed 1631 of the exploratory wells, and the remaining 466 wells were completed by 36 companies, including most of the "major" companies and several of the more active independent companies. Of the total of 1815 strict wildcats, 1463 were drilled by the small operators. The small operators completed 64·3% of the successful exploratory wells, and had 70% of the new field discoveries.

During 1946 the small companies have been more active than in 1945, while the reverse is true of the remaining group, including the major companies.

A table summarizes the completion results for the first half of 1946 by companies for the larger operators, together with totals for the rest of the industry. G. D. H.

**1369. Gas Reserves of the U.S.** E. DeGolyer. *Oil Wkly*, 29.7.46, **122** (9), 62; *Oil Gas J.*, 4.5.46, **44** (52), 80.—At the beginning of 1946 the U.S.A. proved recoverable gas reserve was estimated to be 144,000,000,000,000 cu. ft., including only fields with reserves exceeding 20,000,000,000 cu. ft., except in the Appalachian area, Illinois, Indiana, and Michigan. The pressure base employed was 16·4 lb/sq. in, and the temperature 60° F. In the Appalachian area, Indiana, and Illinois, the reserves are comparatively unimportant in terms of volume and were estimated from analyses of decline curves and pressure data. Elsewhere the reserves were estimated horizon by horizon and field by field. Where possible the pressure-production decline method was employed, and in other cases the volumetric method was used.

The figure given for the total is believed to be conservative, and there may actually be reserves of 200,000,000,000 cu. ft.

Five fields or areas have 43% of the total reserves, 20 account for 61·6%, and 100 for 81·6% of the total reserves.

Except in the Appalachian area, California, and a few northern States, little effort has been made to prospect for gas. Most of it has been found while searching for oil, and in the past many gas-shows were plugged and abandoned or neglected because of low prices or lack of markets. In future such finds are likely to be exploited.

Within the past ten years drilling to greater depths has resulted in the discovery of increasingly greater proportions of hydrocarbons in the gaseous than in the liquid phase than in the earlier search for shallower fields.

The limits of the Hugoton gas-field are not yet known. The productive limits of other gas-fields are also incompletely defined.

Tables give the recoverable reserves by States for the beginning of 1946, with a breakdown according as whether the gas is free or dissolved. There is also a list of reserve estimates (totals) at different dates since 1919. G. D. H.

**1370. Permian Basin to Lead Expanded Operations.** Anon. *Oil Wkly*, 29.7.46, **122** (9), 66.—The Permian Basin sector of West Texas has over 1000 proved locations waiting to be drilled. Pipe-line outlets are operating to capacity, and the construction of new pipe-lines is being considered. Few of the older producing areas have exhausted their drilling locations, and Keystone, TXL, Dean, Slaughter, and Estes-North Ward each has over 100 locations to be drilled.

At Wilmington the prolific "237" schist zone may underlie a substantial part of the field. Many shallow wells will be deepened to this zone. ¼ ml west of the Poso Creek field, Kern County, heavy oil has been found in the Santa Margarita. The Cymric field is small in area, but prolific.

Much exploration in West Central Texas will be for Mississippian and Ellenburger production. In South Texas the most important recent developments are the discovery of the North Albercas field, Webb County, and the extension of the Piedras

Pintas field, Duval County. In East Texas there has been substantial development at Hawkins, and at the Opelika gas-distillate field oil has been found on the north flank.

A new deep production record has been established at Weeks Island, Iberia Parish, Louisiana, where production comes from 13,763–13,778 ft.

The Antioch Southwest pool of Garvin County, Oklahoma, was opened in the Pennsylvanian. The Blue Hill field of McClain County had a big strike in the Chimney Hill section of the Hunton.

Mississippi obtained a new field in Adams County. Of 13 completions in Florida during the first half of 1946, only one was a producer. This lay 1 ml west of production at Sunniland. Notable shows were reported in a test in Monroe County, and in one in Hernando County. Georgia had two dry wildcats. G. D. H.

**1371. Design for Petroleum Expansion Outside the United States.** R. G. Greene. *Oil Gas J.*, 15.6.46, **45** (6), 84.—U.S.A.'s first production abroad was obtained in Mexico in 1900, and in 1914 America's foreign production was limited to Mexico and Rumania. Since 1919 about $3,200,000,000 has been expended on U.S. foreign oil operations, 41% having been spent on exploration and development, and 59% on transportation, refining, and marketing. Since 1919 some 25,300,000,000 brl of foreign reserves (excluding Russia) has been found, and U.S. controls about 45% of this total.

Foreign operations involve a risk of expropriation. Nationalized development has been adopted in many South American countries, but foreign entry is still possible in Venezuela, Colombia, Ecuador, and Peru without undue complications. National development may also be adopted in Czechoslovakia, Yugoslavia, and possibly in Rumania.

Big U.S. investment losses were sustained in Europe and Asia during the recent war. In the Middle East reserves may total 27,000,000,000 brl, 53·15% being held by British companies and 40·47% by American companies. Estimates of Russia's reserves range 6000–50,000 million barrels. G. D. H.

**1372. Canada Vigorously Pushing Oil Search, Concentrating on Western Plains.** W. W. Burns. *Oil Gas J.*, 25.5.46, **45** (3), 94.—Investigations are claimed to have established Alberta as having a tremendous gas reserve. It is possible that one company may erect plant for converting gas to gasoline.

77,000 acres east of the Viking–Kinsella reserve have been proved up.

Only some 12 out of 1600 wells drilled in Western Canada can be considered to have been deep enough to test the whole sedimentary section. The proven reserves are estimated at over 51,000,000 brl, 21,000,000 brl being at Turner Valley and the rest at Norman Wells. Turner Valley's output has fallen since February 1942. Canada produces only 15% of her oil requirements.

1 Brazeau is testing the Madison at 12,000 ft. A flowing well has been completed at Lloydminster, but this will be put on the pump to reduce water-coning and sand movement. Production at Lloydminster comes from the Cretaceous at 1800–1900 ft. The oil is 14·7° A.P.I. gravity. Efforts are being made to get oil at Jumping Pound, where gas and condensate have been found on the crest of the structure. Other foothill anticlines are being drilled.

In the plains Upper Cretaceous to Devonian beds occur. Small oilfields have been found. 1 Redstone in the Norman Wells area was junked at 4874 ft, because of mechanical troubles. No favourable indications had been met. The well was bottomed in Silurian. G. D. H.

**1373. Production in South America Continues Expansion.** Anon. *Oil Gas J.*, 27.4.46, **44** (51), 100.—26 wells are being drilled in Colombia. The production in 1945 averaged 62,534 brl/day. Venezuela has 80 rigs active. Nine wells are under way in Ecuador. No. 1 Bajada was abandoned at 13,206 ft; 2 Rodeo is drilling at 10,500 ft. The 1945 output in Ecuador averaged 6850 brl/day. In Peru a well is to be drilled east of the Andes and 300 ml northwest of the Ganzo Azul field. 46 wells are being drilled in Peru. Slight shows have been reported in a well on the Titicaca national reserve. During 1945 Peru's production averaged 37,500 brl/day. Bolivia has five wells under way. Its 1945 production was 1160 brl/day. Chile's Punta Arenas area well was drilled to 7500 ft. It is said to have a potential of 8000 brl/day

of 39° A.P.I. oil. 51 rigs are active in Argentina, where the 1945 production averaged 62,000 brl/day. Four wells are being drilled in Brazil. G. D. H.

**1374. Creole to Exploit New Concessions Promptly.** Anon. *Oil Gas J.*, 25.5.46, **45** (3), 92.—Creole is carrying out geophysical work in Guarico, Monagas, and in Lake Maracaibo.

The eastern extension of the deeper sands at Maracaibo seems to be cut off by a fault. G. D. H.

**1375. Production in Venezuela Registers Big Increase.** Anon. *Oil Wkly*, 15.7.46, **122** (7), 31.—During the first five months of 1946 Venezuela produced 170,000,000 brl of oil. The output of western Venezuela was 61,296,764 brl in the first quarter of 1946, an increase of 31% over the figure for the same period of 1945. G. D. H.

**1376. Venezuelan Output Still Exceeding 1945 Figures.** Anon. *Oil Gas J.*, 15.6.46, **45** (6), 82.—During the first quarter of 1946 Venezuela produced 90,574,145 brl of oil; the 1945 total was 323,440,191 brl. Tables give the production for these two periods by fields and by companies. G. D. H.

**1377. Western Venezuela's Output up 19·3% in 1945.** Anon. *Oil Gas J.*, 1.6.46, **45** (4), 44.—Western Venezuela produced 218,538,657 brl of oil in 1945; the 1944 figure was 183,199,288 brl. G. D. H.

**1378. British Zone of Germany Producing 12,900 brl Daily.** Anon. *Oil Gas J.*, 15.6.46, **45** (6), 83.—Production in the British zone of Germany has risen from 3920 brl/day when the Allies took over to about 12,900 brl/day. The 24 oilfields and one gas-field of this zone are around Celle and Hamburg, near the Dutch border. Most of the wells are pumpers, but some at Wesendorf flow. Near Bentheim a gas-field produces 10,000,000 cu. ft./day from a limestone.

Before the war Germany's oil reserves were estimated at 85,000,000 brl, and the daily production at 20,000 brl. G. D. H.

**1379. Continuing Search for Oil in Britain.** A. H. Day. *World Petrol.*, 1946, **17** (10), 47–49.—A short historical survey of exploration in Britain is given, together with the present position. 735,000 ft have been drilled in 380 wells by the D'Arcy Exploration Co., 250 of which have been productive. Over 400,000 tons have been produced, mainly from the Eakring district. Output has recently declined. It is stated that prospecting in Britain is uneconomic but the production obtained was valuable in time of war. F. S. A.

**1380. War Oilwells of England.** R. K. Dickie. *Times Trade and Engineering*, 1946, **60** (993), 8–9.—A brief illustrated account of the oilfields in Lancashire and Nottinghamshire. The extent of the latter is indicated on a sketch-map, and the geological structure is shown on simple diagrams. It is considered probable that other oilfields, of a similar size, may be discovered. V. B.

**1381. Cradle of Galician Oil in Midst of Revival.** Anon. *Oil Wkly*, 15.7.46, **122** (7), 31.—The Bitkov field is being revived, 16 wells being in operation. 100 new wells have been drilled in the Devonian oil horizons at Tuimazy which has an output of 29,000 brl per day. G. D. H.

**1382. Roumanian Production Still Short of Pre-War Total.** Anon. *Oil Gas J.*, 1.6.46, **45** (4), 44.—During 1945 Roumania produced 32,480,000 brl of crude, compared with 24,584,000 brl in 1944. The 1938 production was 64,970,000 brl. About 21,700,000 brl of the 1945 production went to Russia. G. D. H.

## TRANSPORT AND STORAGE.

**1383. Steady Turbulent-Flow Equations of Continuity, Momentum, and Energy for Finite Systems.** E. R. Van Driest. *J. Appl. Mech.*, 1946, **13** (3), A-231–A-238.—The

steady turbulent-flow equations for continuity, momentum, and energy were derived for certain finite systems. It was found that for an incompressible fluid the continuity relation contained neither non-uniform velocity-distribution correction terms nor turbulence terms, that the momentum equation involved velocity-distribution corrections and mean-square velocity fluctuations, and that the energy relation contained not only velocity-distribution corrections and mean-square terms, but in addition mean-cube and double- and triple-correlation terms. The correction factors for non-uniform velocity distribution were evaluated for fully developed open channel and pipe flow. Through the momentum law the effect of turbulence was shown quantitatively in the case of the hydraulic jump in open channels and the sudden expansion in closed conduits. A. H. N.

**1384. Fuel Oil Storage.** Anon. *Gas Oil Pwr*, 1946, **41**, 351–355.—Layouts suitable for barrel, tank, and bulk storage are described, and recommendations are laid down as to the construction of tanks. The draw-off connection should be so placed that dead space is available for the settlement of water and solid matter, and to this end the tank should slope towards the back so that sludge can be drawn off through a drain-cock. Additional fittings include dipsticks and filters, of which two in parallel should be used. H. C. E.

**1385. Gasoline Loss Control and Molecular Weight Determinations.** H. G. Koefoed. *J. Inst. Petrol.*, 1946, **32**, 529–574.—The causes of loss of products are systematically analyzed. Loss by evaporation is the main type studied in detail. After reviewing briefly a previous method, a new scheme is described. The errors of analyses are discussed and the probable overall error evaluated. The system uses an absorbing oil in an Orsat apparatus to determine the quantity of hydrocarbon vapour in air. The method can also be used to estimate the molecular weight of the vapours. The results of testing the methods on laboratory and large-scale are discussed. The possible methods of combating evaporation losses are finally described. A. H. N.

**1386. Effects and Corrections of Gas-Pulsation Problems.** F. M. Stephens. *Oil Gas J.*, 14.9.46, **45** (19), 78.—The effects of vibration on equipment when gas, air, or steam is compressed is discussed.

Besides effects on lines and equipment, pulsation flow is a chief cause of inaccurate orifice metering as high as 20%, regardless of location of meter. It is frequently impossible to read pressure-gauges.

Loss of horsepower due to high instantaneous peaks and to the extra pressure drop required to drive a pulsative flow through a transmission line is another effect.

Attempts to tie down the points of excessive vibration displacements structurally often result in the necessity for additional supports elsewhere, owing to shift of the point of displacement. Recently mechanical vibrational dampeners have been installed at certain points in the system. They consist of weights with springs or rubbers, or springs alone. Exact location is necessary, and a partial cure only is usually achieved. Meter readings errors are reduced by installing pinching valves in the lead lines. Volume bottles, having five to 15 times the compressor displacement, fitted to both discharge and suction side of a compressor, minimize the effects of reflections and reduce horsepower loss to a minimum. Pulsation dampeners on the filter principle, smooth out the flow, and reduce necessity for hold-down systems, and when fitted to discharge and suction side of compressors result in conditions which eliminate instantaneous pressure conditions within the cylinder when the valve is open on the discharge side, and in a uniform pressure condition at the time the suction valve is open. G. A. C.

## Refinery Operations.

### Refineries and Auxiliary Refinery Plant.

**1387. Design Plan of United's New Carthage Plant.** G. Weber. *Oil Gas J.*, 20.7.46, **45** (11), 86.—A plant producing daily 170,000 gal of liquid products is described.

The new United Gas Pipe Line Co.'s condensate-natural gasoline-recovery plant in

the Carthage, Texas, gas-field processes 150,000,000 cu. ft. of raw gas daily to extract a total of 170,000 gal of liquid products.

The gathering system involves more than 100 miles of lines serving 81 wells from three formations.

Products made include kerosine, motor fuel, naphthas, butanes, natural gasoline, and liquefied petroleum gases.

The raw gas is taken into the scrubbers at 1050 p.s.i.g. when condensate is removed, the stripped gas going to the absorbers and low-pressure gas lines. Condensate is dehydrated, flashed, and fractionated to produce light motor fuel, naphtha, and kerosine; fuel oil being taken off as side streams. Absorption oil make-up is supplied by kerosine. The absorption oil, after contacting the gas, is stripped to remove hydrocarbons, and finally returned to cycle; the stripped gas being dehydrated in four towers packed with specially treated bauxite containing 60–70% of alumina, the cooled gas being mixed with the gas entering the high-pressure pipe-line. The desiccant is re-activated by passing hot dry gas at 400° F through the towers for 8 hours. G. A. C.

**1388. Design and Cost Factors for Steam and Power Generation in the American Refinery.** W. F. Ryan. *Oil Gas J.*, 20.7.46, **45** (11), 97.—A review is given of American refinery power practice and costs, and a hypothetical plant discussed.

The commercially developed maximum operating pressure is 2200 p.s.i. with a throttle temperature of 950° F for high-pressure steam. In the hypothetical plant this steam is passed through a high-back-pressure turbine exhausting at 450 p.s.i. and generating approximately 40 kWh per 1000 lb steam. The 450 p.s.i. steam is reheated to 850° F for use with low-pressure turbine generators and auxiliary drive turbines.

These generators would be designed with controlled extraction at 300, 125, and 15 p.s.i. Heat exchangers are used for extraction of heat from the boiler blowdown, the equipment being located between stages of the boiler feed-pumps. Condensate is returned to the power plant from all closed heat exchangers in the refinery. A double-circulating system is designed to reduce the handicap of high blowdown, which is costly due to loss of heat and cost of treating replacement water. Future designs should yield more than 100 kWh per 1000 lb of process steam at a heat consumption of not more than 4500 B.Th.U. per kWh and at a capital cost of less than $125 per kW above the cost of a low-pressure boiler plant supplying only process steam. High pressures of 3000–3200 p.s.i. are envisaged.

A survey of 85 plants has shown that the pre-war capital cost of power generating equipment was about $105 per kW, the unit investment decreasing with increasing steam pressure. In contrast, the American public utility has an investment of more than $300 per kW in electric plant above. G. A. C.

**1389. Dividends from Furnace Draft.** R. Reed. *Oil Gas J.*, 14.9.46, **45** (19), 80.—Results both of use and misuse of furnace draft conditions are discussed.

High maintenance and fuel costs, danger of injury to personnel, and impairment of process conditions result from neglect of draft conditions. A curve illustrates the amount of vacuum which must be maintained to avoid a condition of pressure at any place in the furnace, and an example is worked out.

Draft gauges manifolded to allow for furnace conditions in a number of places with a single instrument are very advantageous. With an indication of 0·02-in $H_2O$ at the arch sufficient draft will exist at the burner levels for all practical purposes.

Factors involved in furnace-draft design include the radiant and convection sections, a breeching, a damper, and a stack. A table shows the amount of draft which can be obtained from stacks of various heights and diameters; the stack is the key to furnace draft conditions. An inadequate stack cannot give good draft conditions. Maintenance costs will increase with pressure on the furnace, since the hot gases overheat the steel supporting arch and walls, and outward flow of hot gases from peep holes may injure personnel. In high wind conditions accurate draft indications are hard to obtain. Differences of 0·15-in $H_2O$ between windward and leeward sides occur in moderate winds. A figure shows a suggested correction measure, consisting of 1/16-in holes drilled 10 ft apart in a ¼-in manifold encircling the furnace, to permit balancing pressures on each side of the furnace. The atmospheric connection into the

manifold is made half-way between any two 1/16-in holes in the pipe. Furnace pressures can be controlled by regulation of damper or of the secondary air control.

Too great a draft will waste fuel, owing to excessive infiltration of air into the furnace, too little draft causes a flow of hot gases from the furnace. Secondary air-entry area should be such as to maintain the required excess air with increased furnace draft.

G. A. C.

**1390. An Echanger Design.** W. L. Nelson. *Oil Gas J.*, 20.7.46, **45** (11), 117.—No. 102 in the *Refiner's Notebook* series serves as a summary of many previous issues on heat exchange.

The design of an exchanger for a particular purpose is considered through a series of steps, including economical approach, heat duty, routing, number of passes, tube transfer rate, diameter of shell, shell velocity, overall transfer rate, and pressure drop. An example is given and worked out. G. A. C.

## Cracking.

**1391. Modern Catalytic Processing in Summary.** S. S. Allender. *World Petrol.*, 1946, **17** (8), 60–62.—This is an introduction to the following papers and reviews the types of catalytic processes now in use. **Catalytic Cracking for the Small Refinery.** O. W. Willcox. *Ibid*, **17** (8), 63.—Some figures are given to support the view that the smaller refinery should change to catalytic cracking. It is stated that 70% of the refineries in U.S. are not thus equipped. **The Small Kellogg Fluid Cat-Cracker.** Anon. *Ibid*, **17** (8), 64, 65.—A 4000-brl/day unit is described. It occupies an area of 1650 sq. ft. The reactor, regenerator, and precipitator are all supported at the same elevation, 69 ft above ground. Gas velocities are reduced, and the plant has been generally simplified as a result of experience. A flow diagram and tables showing the relative economics of 4500 brl/day unit operating on 39° A.P.I. mixed base crude and a 9500 brl/day unit using 36° A.P.I. paraffinic crude as stock are presented. Before depreciation charges the costs are 5·29 and 5·57 cents per gallon respectively. Optimum yield is 45–55%. Plants designed for 1700 and 2250 brl/day are mentioned. **Small Thermofor Cat-Cracker.** Anon. *Ibid*, **17** (8), 66–67.—Newer designs are tending towards moving catalyst yet retaining the inherent safety features. Small units in capacity range of 1000–5000 brl/day are available. A flow sheet and cost data are given. **Small U.O.P. Cat-Cracker.** Anon. *Ibid*, **17** (8), 68–69.—A flow diagram is given, together with explanatory outline. Some degree of automatic control is indicated on a 2600 brl/day unit. Improvements over the large units are listed. Tables are presented showing the improved performance obtained by recycling (31° A.P.I. gas oil as feed) over once through operation and the effect of reactor temperature on the octane number of the product. Some economic data are included. The unit is self-supporting as regards steam. Other power requirements are discussed. **Cycloversion for the Small Refinery.** Anon. *Ibid*, **17** (8), 70.—This paper takes the same form as those above. Low maintenance costs are claimed owing to the fixed bed. The plant is self-supporting for steam. F. S. A.

**1392. Indiana Standard's Three Cat Cracking Units.** Anon. *World Petrol.*, 1946, **17** (8), 82, 83.—Standard Oil Company (Indiana) is to have three new fluid catalytic cracking units. Each will be capable of processing 25,000 brl/day of gas oil. A vapour-recovery plant is to work in conjunction with each. F. S. A.

## Chemical and Physical Refining.

**1393. Removal of Chlorine and Gum Formers from Alkylates.** R. G. Haldeman and W. A. Pardee. *Industr. Engng Chem.*, 1946, **38**, 242–246.—The alkylates produced by the reaction of *iso*butane and ethylene using an aluminium chloride catalyst possess very high potential gum values, and organic chlorides may be present to the extent of 0·10% by weight. The removal of these chlorides is necessary because of their detrimental effect on the tetraethyl lead susceptibility of the gasolines into which the alkylates are blended. A detailed study has therefore been made of the treatment of chlorine-containing alkylate in the vapour phase over the bauxite catalyst, Porocel. It is shown that the gum-forming constituents of the alkylates can be removed under

conditions similar to those for chlorine removal, but that the severity of this treatment is critical, since by over-treatment the gum-forming properties of the gasoline are increased. A. W.

## Special Processes.

**1394. Reactions of Aliphatic Hydrocarbons with Sulphur.** H. E. Rasmussen, R. C. Hansford, and A. N. Sachanen. *Industr. Engng Chem.*, 1946, **38**, 376–382.—A process is described for reacting aliphatic hydrocarbons, containing at least four carbon atoms in a straight chain, with sulphur to give the corresponding olefin, diolefin, and thiophene or thiophene homologue. If the charge-stock is commercial (95%) *n*-butane, the following variations of the process are possible: (*a*) an 80% conversion to a product consisting of 35% thiophene, 35% butadiene, and 30% *n*-butylene by weight by recycling unreacted butane; (*b*) a 75% conversion to equal weights of thiophene and butadiene by recycling unreacted butane and butylene; or (*c*) a 50% conversion to thiophene alone by recycling unreacted butane, butylene, and butadiene. A. W.

**1395. Production of Gasoline from Natural Gas.** Anon. *World Petrol.*, 1946, **17** (8), 52–54.—A brief outline is given of the development of the Hydrocol process (Hydrocarbon Research, Inc.) which is said to be of special value for gas deposits not supplied with long-distance transportation facilities. Gasoline production cost is comparable with that from crude, in the Gulf Coast area. Initially only gasoline, gas oil, and alcohols will be produced. The process is stated to consist of three stages, representing advances over former practice: oxygen separation, production of synthesis gas under high temperature and pressure, and catalytic reduction of the gas to desired products. No details are given. F. S. A.

**1396. Hydrolysis and Isomerization of Chlorotoluenes to *m*-Cresol.** R. N. Shreve and C. J. Marsel. *Industr. Engng Chem.*, 1946, **38**, 254–261.—The simultaneous hydrolysis and isomerization of *o*-chlorotoluene and *p*-chlorotoluene have been investigated. The optimum operating conditions are 350° C, 2·5 moles of sodium hydroxide per mol of chlorotoluene, and a 2-hour reaction time. Cresol mixtures of 60% *m*-cresol content are obtained. A. W.

**1397. Lubricating Oils from Fischer–Tropsch Olefins, Using Water-Gas as Raw Material.** G. M. Dazeley and D. Gall. *Petroleum*, 1946, **9** (9), 208–210.—Because of their higher olefin content, products from the Fischer–Tropsch process using water-gas ($CO : H_2 = 1 : 1$) are more promising raw materials for polymerization to lubricating oils than products in the same boiling-range using synthesis gas ($CO : H_2 = 1 : 2$).

With a given olefin chain-length experimental results showed that the absolute viscosity of the lubricating oil is inversely proportional to reaction temperature, while the V.I. remains approximately constant. With a given reaction temperature, the absolute viscosity is inversely proportional to olefin chain-length. Oxidation-stability is little influenced by reaction temperature and chain length. Generally, the oils were superior to those from the product of synthesis-gas. K. C. G. K.

**1398. Monomercuration of Aromatic Hydrocarbons. Paracymene.** T. F. Doumani and K. A. Kobe. *Industr. Engng Chem.*, 1946, **38**, 248–250.—Monomercurated products can be obtained from *p*-cymene in high yield. A new method of separating the 2- and 3-isomers is given. The bactericidal properties of some cymyl derivations are compared with basic phenylmercuric nitrate. A. W.

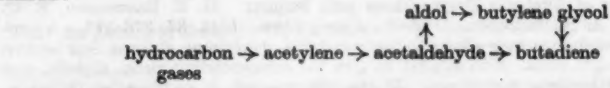
**1399. Monomercuration of Aromatic Hydrocarbons. Toluene.** A. J. Barduhn and K. A. Kobe. *Industr. Engng Chem.*, 1946, **38**, 247–248.—Process conditions have been developed whereby toluene is exclusively monomercurated with a yield of 98%. The orientation is approximately in the ratio *ortho* : *meta* : *para* = 43 : 13 : 44. A. W.

**1400. Synthetic Fuels in Germany. 3(3)-Fischer–Tropsch Process, Lubricating Oils and Acetylene.** Anon. *Petroleum*, Sept. 1946, **9** (9), 215.—The production both of

synthetic rubber, and the chemicals used—*e.g.*, acetylene, butadiene, and styrene—are discussed.

An I.G. plant at Huls had a rated capacity of 4000 tons of Buna S per month and was ¾ sq. mile in area.

Buna S is made by polymerizing butadiene and styrene. The former was made as follows:




The styrene was made from benzene from coal-tar plants in the Ruhr and ethylene produced at Huls.

Details of acetylene production and subsequent manufacture of butadiene are given. K. C. G. K.

**1401. Synthetic Fuels in Germany. 3(2)-Fischer–Tropsch Process, Lubricating Oils and Acetylene.** *Petroleum*, Aug. 1946, **8** (9), 191.—During the war the Germans made considerable quantities of synthetic lubricating oils. The Kuhlmann plant at Lestaque near Marseilles produces 25 tons of product per day.

In order to produce 1 ton of lubricant, this plant requires as raw materials 600 kg of Fischer–Tropsch gas oil, 600 kg of benzole, and 160 kg of dichlorethane. The oils formed consist of polybenzenes with long paraffinic chains attached, giving a high V.I. and a low pour-point.

The second German process is that of the Kuhlmann Co. A pilot plant is in operation at Harnes, near Lille. The starting material is Fischer–Tropsch spirit, which is as olefinic as possible (unlike the gas oil used in the first process, which should be as low in olefins as possible). The spirit is mixed with 3% of aluminium chloride, and remains in contact with it for 5 hours at room temperature. Two layers form, the lower containing a heavy polymer bound chemically with the aluminium chloride, which is removed by treatment with caustic soda and washing with water. The upper layer contains paraffinic spirit and free polymer. The spirit is removed by steam-stripping. The properties of these oils are given in tabular form.

During the war four underground lubrication-oil plants were constructed by the Germans. None of these was used, however. K. C. G. K.

**1402. Vapour-Phase Nitration of Neopentane and Neohexane.** A. P. Howe and H. B. Hass. *Industr. Engng Chem.*, 1946, **38**, 251–253.—A study of the vapour-phase nitration of *neo*pentane and *neo*hexane at approximately 410°C has been made. Contact times vary from 1 to 1·5 sec and the molal ratio, hydrocarbon : nitric acid from 0·9 to 3·5 : 1·0. In particular, *neo*hexane appears to give good yields of nitroparaffins, the figure being well above 40% of theoretical, although no attempt was made to discover optimum conditions. 2 : 2-Dimethyl-1-nitrobutane, 3 : 3-dimethyl-1-nitrobutane, and 2 : 2-dimethyl-1-nitropropane are new compounds identified. A. W.

## Patents.

**1403. Patents on Refining Processes and Products.** C. E. Hemminger, assr to S.O. Dev. Co. U.S.P. 2,397,485, 2.4.46. A process of catalytic cracking in which the oil vapours are preheated in a suspension of a powdered inert material prior to the conversion stage.

A. P. Lien and B. H. Shoemaker, assrs to S.O.C. Indiana. U.S.P. 2,397,495, 2.4.46. Ethylbenzene is produced from an alkylbenzene containing at least 3 carbon atoms in the alkyl group by catalytic treatment with hydrogen fluoride and boron fluoride.

R. L. May, assr to Sinclair Refining Co. U.S.P. 2,397,498, 2.4.46. Salicylic acid is esterified with a cut of refinery olefins using boron trifluoride as catalyst under conditions minimizing alkylation.

R. W. Richardson, assr. to S.O. Dev. Co. U.S.P. 2,397,505, 2.4.46. A bentonite clay activated by acid treatment then impregnated with an active metallic oxide is used as a cracking catalyst. Its activity is maintained by regular acid treatment.

A. W. Francis and E. E. Reid, assrs to Socony Vacuum Oil Co. U.S.P. 2,397,542, 2.4.46. Ethylbenzene is prepared by contacting benzene with $AlCl_3$ at 100–150° C in an atmosphere of ethylene at around 100 lb pressure.

A. H. Schutte, assr to The Lummus Co. U.S.P. 2,397,566, 2.4.46. An apparatus is described for the preferential adsorption of a gas in a mixture of gases by means of a finely divided adsorbent material. Equipment for the recovery of the gas and the adsorbent is also described.

R. T. Bell, H. O. Folkens, and C. M. Thacker, assrs to The Pure Oil Co. U.S.P. 2,397,638, 2.4.46. Hydrocarbon oils are cracked at between 375° and 750° C in the presence of a small amount of hydrogen bromide and oxygen.

L. Berg, G. L. Sumner, Jr., and C. W. Montgomery, assrs to Gulf Research & Dev. Co. U.S.P. 2,397,639, 2.4.46. Olefins are isomerized by passage at 300–600° C over alumina impregnated with anhydrous hydrogen chloride.

L. M. Henderson and W. G. Annable, assrs to The Pure Oil Co. U.S.P. 2,397,662, 2.4.46. Penna. cylinder stock is distilled under light cracking conditions in the presence of steam and light hydrocarbon vapours until about 91% distillate is obtained. After the addition of 15% petroleum and removal of the light fractions boiling within and below the gas oil range the stock is centrifugally dewaxed with naphtha at −35° F.

H. G. Smith and T. L. Cantrell, assrs to Gulf Oil Corpn. U.S.P. 2,397,702, 2.4.46. A mineral oil additive which is the metal salt of a sulphurized derivative of the reaction product of ricinoleic acid and diaryl chlorophosphite.

J. W. Teter, assr to Sinclair Refining Co. U.S.P. 2,397,705, 2.4.46. In using a finely divided catalyst to react olefins and ammonia a slurry is made of the catalyst in liquid ammonia before it is passed to the reaction zone.

C. Weizmann. U.S.P. 2,397,715, 2.4.46. Aromatic hydrocarbons are produced from aliphatic and hydroaromatic oils by contact with a copper-iron mixture at 600–700° C and around atmospheric pressure at a space velocity of 0·16–0·19 litres per litre of catalyst per hour.

A. J. Shmidl, assr to S.O. Dev. Co. U.S.P. 2,397,760, 2.4.46; E. F. Wadley, assr to S.O. Dev. Co. U.S.P. 2,397,768–9, 2.4.46. Processes for the recovery of hydrogen halides from their mixtures with other gases.

B. T. Anderson and M. T. Flaxman, assr to Union Oil Co. U.S.P. 2,397,771, 2.4.46. 0·01–0·5% of a high mol. wt. acidic material obtained by the caustic treatment of petroleum fractions is added to diesel fuel oil.

R. B. Thompson and J. A. Chenicek, assrs to U.O.P. Co. U.S.P. 2,397,820, 2.4.46. Normal butane is isomerized employing a Friedel–Crafts type catalyst, then alkylated with ethylene and hydrogen chloride in the presence of the same type catalyst.

C. R. Clark, assr to Allied Chemical and Dye Corpn. U.S.P. 2,397,839, 2.4.46. Toluene is recovered from its mixture with non-aromatics of the same boiling range by distillation under suitable conditions with *p*-dioxane.

A. B. Hersberger and K. M. Thompson, assrs to Atlantic Refining Co. U.S.P. 2,397,859, 2.4.46. A liquid fuel is produced by the suspension of a finely divided bituminous fuel in oil stabilized with an acid such as hydrocarbon sulphonic acid or phosphoric acid.

V. N. Jenkins, assr to Union Oil Co. U.S.P. 2,397,868, 2.4.46. Lub. oil is dewaxed to give a high-m.-p. wax and a low-m.-p. wax by varying the concentration of methyl ethyl ketone in the dewaxing solvent. The ketone poor solvent is distilled with sufficient water to recover a benzene free cut of methyl ethyl ketone.

J. E. Shields, assr to Alox Corpn. U.S.P. 2,397,904, 2.4.46. A gun oil composition made up of 5 parts wool grease, 0·4 part lecithin, 4·35 parts methyl esters of high mol. wt. saturated aliphatic acids (derived from lub. oil oxidation), and 90·25 parts (by wt.) of a highly refined low pour point lub. oil.

P. L. Cramer and C. R. Begeman, assrs to General Motors Corpn. U.S.P. 2,397,925, 9.4.46. Paraffin hydrocarbons are isomerized, using an aluminium halide in the presence of a nitroparaffin as a promoter.

D. E. Burney, E. L. d'Ouville and C. M. Hull, assrs to S. O. C. Indiana. U.S.P. 2,397,945, 9.4.46. Propylene is polymerized to synthetic lub. oils by means of $AlCl_3$ under suitable conditions.

H. M. Fraser, assr to International Lubricant Corpn. U.S.P. 2,397,956, 9.4.46. A grease is manufactured from a lub. base and the lithium soap of a 12-hydroxystearic acid.

R. A. Macke and H. J. Zoeller, assrs to S.O. Dev. Co. U.S.P. 2,397,969, 9.4.46. Paraffin scale is sweated then acid treated, distilled over excess NaOH solution, then sweated further. The refined wax is improved in stability to heat and light.

S. W. Wilson, assr to S.O. Dev. Co. U.S.P. 2,397,996, 9.4.46. Improvements in the process of extracting butadiene from a mixture of saturated and unsaturated hydrocarbons by means of ammoniacal cuprous acetate.

D. G. Brandt, assr. to Cities Service Oil Co. U.S.P. 2,398,074, 9.4.46. A two-stage thermal cracking process operated under conditions to produce a maximum yield of toluene.

L. C. Brunstrum and H. J. Liehe, assrs to S.O.C. Indiana. U.S.P. 2,398,075, 9.4.46. An improved lime grease is obtained when hydrating a lime soap in the presence of a preferentially water-soluble surface-active substance capable of appreciably reducing the interfacial tension between water and a hydrophobic phase.

M. R. Lipkin, assr to Sun Oil Co. U.S.P. 2,398,101, 9.4.46. Aromatic hydrocarbons are extracted from gasoline and kerosine by adsorption on silica gel and recovered from the gel by means of a liquid desorbing agent in a cyclic process.

H. Schindler, assr to The Pure Oil Co. U.S.P. 2,398,120, 9.4.46. A rust inhibitor for turbine oil is produced by suitable treatment of the soda extract obtained in removing phenols from petroleum distillates with caustic soda.

C. M. Thacker and R. T. Bell, assr to The Pure Oil Co. U.S.P. 2,398,126, 9.4.46. Mercury vapour is mixed with hydrocarbons prior to dehydrogenation over a solid porous catalyst acting as a carrier for suitable metals and oxides.

L. C. Brunstrum and K. J. Liehe, assr to S.O.C. Indiana. U.S.P. 2,398,173, 9.4.46. A grease is made up with 5% lithium soap, a major proportion of lub. oil, and 0·2–2% of an unsulphurized ester of a polyhydric alcohol and an acid.

R. M. Cole, assr to Shell Dev. Co. U.S.P. 2,398,175, 9.4.46. Sulphide catalysts are reactivated by stage treatment involving steam, free oxygen, hydrogen sulphide, then hydrogen.

J. W. Loy, assr to Phillips Petroleum Co. U.S.P. 2,398,186, 9.4.46. Regeneration of the catalyst employed in catalytic cracking under fixed bed conditions.

T. E. Sharp, assr to S.O.C. Indiana. U.S.P. 2,398,193, 9.4.46. A rust preventive oil is composed of lub. oil, an ester of anhydroalkitol and a carboxylic acid, and an aliphatic soap of an oil soluble petroleum sulphonic acid.

E. W. Zublin, E. R. White and E. R. Barnum, assr to Shell Dev. Co. U.S.P. 2,398,202, 9.4.46. A corrosion preventive composition consisting of a lub. oil containing in fine dispersion a small amount of a dicarboxylic acid containing at least 16 C atoms, the two acid radicals being linked by an element from the sulphur group.

K. J. F. Dutson, Jr. and D. A. Smith, assr to S.O. Dev. Co. U.S.P. 2,398,213, 9.4.46. A surge device for reducing thermal decomposition of oil in high-temperature accumulators such as the bottom of a tower.

E. W. Hunt, assr to S.O. Dev. Co. U.S.P. 2,398,228, 9.4.46. A method of starting up a fluid catalytic cracking unit.

J. D. Morgan and R. E. Lowe, assrs to Cities Service Oil Co. U.S.P. 2,398,242, 9.4.46. A paint and varnish remover, which consists of a paste of water, kerosine, monoethanolamine, its oleate, nitropropane, and isopropyl alcohol.

D. T. Rogers and H. Feldhusen Jr., assrs to S.O. Dev. Co. U.S.P. 2,398,253, 9.4.46. An olefin is used in the presence of a boron halide catalyst to alkylate a phenol prior to the preparation of the sulphide.

J. C. Zimmer and A. J. Morway, assrs to S.O. Dev. Co. U.S.P. 2,398,271, 9.4.46. A lube oil additive is obtained by sulphurizing the polymer produced in the vapour-phase clay treatment of a steam-cracked petroleum distillate.

J. M. Barron, assr to The Texas Co. U.S.P. 2,398,280, 9.4.46. A combination process of catalytic and thermal cracking.

E. Bartholomew, assr to Ethyl Corpn. U.S.P. 2,398,281–2, 9.4.46. Lead tetraethyl and lead tetraethyl-iron carbonyl compositions based on graphical relations between the quantities of the components.

G. H. Denison Jr. and P. C. Condit, assrs to California Research Corpn. U.S.P. 2,398,414–16, 16.4.46. Organic selenides are employed as lub. oil additives.

A. F. Garvin. U.S.P. 2,398,424, 16.4.46. Process for manufacture of ceresin from a paraffin-base residuum involving dilution with naphtha, filter pressing, distillation, and further oil extraction.

E. C. Hughes, assr to S.O.C. Ohio. U.S.P. 2,398,429, 16.4.46. A water-free cutting oil is obtained by the reaction between phosphorus pentasulphide and a mineral oil and is made non-corrosive by inclusion of an unsaturated fat and the dioctyl ester of sodium sulpho-succinic acid.

O. Roelen and W. Feisst, vested in the Alien Property Custodian. U.S.P. 2,398,462, 16.4.46. A process for preparing the iron-group-type catalysts used in the hydrogen–carbon monoxide synthesis of gasoline hydrocarbons.

W. A. Schulze and G. H. Short, assrs to Phillips Petroleum Co. U.S.P. 2,398,468, 16.4.46. Ammonia (0·001–1·0% by wt) is used to inhibit polymerization of butadiene during transport and storage.

W. E. Vaughan and F. F. Rust, assrs to Shell Dev. Co. U.S.P. 2,398,479–81, 16.4.46. Ultra-violet rays are employed in the preparation of organic sulphur compounds, halogenated mercaptans, and thioethers, and in catalysed abnormal addition reactions.

E. L. d'Ouville and B. H. Shoemaker, assrs to S.O.C. Indiana. U.S.P. 2,398,495, 16.4.46. A syntholube is obtained by alkylating the viscous polymer of a normal olefin with *iso*butane in the presence of $AlCl_3$ catalyst at normal temperatures.

R. B. Greenburg, assr to Allied Chemical and Dye Corpn. U.S.P. 2,398,526, 16.4.46. Paraxylene is recovered from a hydrocarbon oil by fractional melting of a mixture of the oil with an alkanol containing not more than two carbon atoms.

H. E. Messmore, assr to Phillips Petroleum Co. U.S.P. 2,398,546, 16.4.46. Design of a thermally insulated catalyst chamber.

G. R. Reading, assr to Phillips Petroleum Co. U.S.P. 2,398,557, 16.4.46. Aluminium chloride catalyst by heat and pressure treatment is formed into a soft plastic coherent mass, formed into a desired shape and hardened.

W. R. Smith and A. R. Goldsby, assrs to The Texas Co. U.S.P. 2,398,563, 16.4.46. Straight-chain hydrocarbons +1% by wt. aromatics are isomerized by means of an aluminium halide-hydrocarbon complex. The latter containing the aromatics is reacted with an olefin under alkylating conditions, the alkylated aromatics are removed and the complex is recycled to the isomerization stage.

W. A. Bailey Jr. and C. W. Bittner, assrs to Shell Dev. Co. U.S.P. 2,398,610, 16.4.46. Preparation of stabilized alumina for catalysis.

J. D. Morgan and R. E. Lowe, assrs to Cities Service Oil Co. U.S.P. 2,398,662, 16.4.46. A compass fluid which flows at −80° F and has a small viscosity–temperature change under working conditions is comprised of 1-nitropropane, ethyl silicate, and pseudo-cumene.

W. A. Schulze, assr to Phillips Petroleum Co. U.S.P. 2,398,674, 16.4.46. A highly aromatic gasoline is obtained when a gasoline consisting of approximately equal proportions of olefins, paraffins, naphthenes, and aromatics is contacted with a bauxite catalyst at 1000–1300° F.

H. L. Yale and G. W. Hearne, assrs to Shell Dev. Co. U.S.P. 2,398,685, 16.4.46. Acyclic monoketones are obtained from normal butylene by treatment with an oxygen containing mercury salt in aqueous sulphuric acid.

W. J. Bloomer, assr to The Lummus Co. U.S.P. 2,398,689, 16.4.46. Ethylene glycol lower alkyl ether is used as an entrainer in the azeotropic distillation of styrene associated with close-boiling aromatics.

B. S. Greensfelder and S. Z. Perry, assrs to Shell Dev. Co. U.S.P. 2,398,739, 16.4.46. A catalytic cracking process employed silica–alumina–zirconia diluted with a non-adsorptive and non-combustible mineral.

C. H. Angell, assr. to U.O.P. Co. U.S.P. 2,398,759, 23.4.46. A fluid catalytic process.

G. C. Connolly, assr to S.O. Dev. Co. U.S.P. 2,398,773, 23.4.46. Alumina plus a salt containing boron and fluorine is used as a cracking catalyst.

L. W. Cook, assr to The Texas Co. U.S.P. 2,398,819, 23.4.46. A catalytic cracking process in which two catalysts are used, aluminium fluoride to crack naphthenes, and boron oxide to crack paraffin hydrocarbons.

S. R. Funsten, assr to Filtrol Corpn. U.S.P. 2,398,825, 23.4.46. An acid-activated clay.

J. C. Munday, assr to S.O. Dev. Co. U.S.P. 2,398,846, 23.4.46. The products of catalytically cracked gas oil are refined by mild catalytic hydrogenation to saturate the olefins and convert the high-boiling aromatics into naphthenes. A saturated aviation gasoline is separated and the hydro gas oil is returned to the cracking process.

E. W. Thiele, assr to S.O.C. Indiana. U.S.P. 2,398,869, 23.4.46. A continuous process of alkylation of *iso*paraffins by gaseous olefins to produce an aviation safety fuel.

J. W. Teter, assr to Sinclair Refining Co. U.S.P. 2,398,899, 23.4.46. A catalyst for amination of olefins by ammonia comprising a metal such as cobalt or nickel in suspension on acid-treated bentonite.

C. B. Linn, assr to U.O.P. Co. U.S.P. 2,398,905, 23.4.46. Acids of phosphorus, their anhydrides or esters are added to liquid hydrogen fluoride used as the catalyst in the alkylation process.

P. Miller, assr to Standard Catalytic Co. U.S.P. 2,398,908, 23.4.46. The $C_4$ cut of refinery gases and $C_3$–$C_5$ olefins are converted into aviation gasoline by a series of steps involving hot acid polymerization, hydrogenation, distillation and alkylation.

A. C. Byrns, assr to Union Oil Co. U.S.P. 2,398,919, 23.4.46. A complex salt of two metals from the groups iron cobalt nickel and chromium molybdenum is used with hydrogen to desulphurize sulphur-contaminated oils.

W. W. Gary, assr to Filtrol Corpn. U.S.P. 2,398,930, 23.4.46. Butadiene is separated from other low-boiling hydrocarbons by steps involving catalytic polymerization, distillation, and de-polymerization.

M. H. Kollen, assr to Union Oil Co. U.S.P. 2,398,943, 23.4.46. A blend of a high boiling *iso*paraffin and a small proportion of a high mol. wt polymer of a low boiling olefin is used as a hydraulic fluid.

A. H. Schutte. U.S.P. 2,398,967, 23.4.46. A design of a centrifugal filter apparatus to separate a mixture of a liquid and a lighter solid.

J. M. Schantz, assr to Hercules Powder Co. U.S.P. 2,399,063, 23.4.46. A grease is obtained by the addition to a mineral oil of an oil-soluble soap of a rosin having at least 50% of the double bonds saturated with hydrogen.

W. S. Bonnell and W. W. Weinrich, assrs to Gulf Research & Dev. Co. U.S.P. 2,399,093, 23.4.46. A process for isomerizing paraffin hydrocarbons and for alkylating branched paraffin isomers for the production of alkylate using aluminium halide catalyst.

A. P. Lien, assr to S.O.C. Indiana. U.S.P. 2,399,126, 23.4.46. Ethers are produced by the interaction of olefins and alcohols using hydrogen fluoride and boron fluoride as catalyst. G. R. N.

## Safety Precautions.

**1404. Tetra-Ethyl Lead Poisoning.** D. A. K. Cassels and E. C. Dodds. *Brit. Med. J.*, 1946, ii, 681–685.—T.E.L. has sufficient v.p. to be absorbed in appreciable amounts through the lungs. At ordinary temperature air saturated with T.E.L. contains 5 mg Pb/litre; the maximum safe concentration is $1{\cdot}5 \times 10^{-4}$ mg Pb/litre. The toxicity of T.E.L. is solely due to its Pb content, but is accentuated by its fat solubility causing selective concentration in nervous tissue. T.E.L. poisoning is thus an intoxication of the central nervous system. Exposure to vapours of leaded fuel in can filling and pumping installations during the war gave rise to conditions of potential hazard, whilst the post-war cleaning of storage tanks (especially those underground) gave rise to 25 cases (two fatal) of poisoning. These are reviewed, six case histories being given. Initial symptoms are disturbances of sleep and of the alimentary tract. The classical signs of Pb poisoning either do not occur or are subsidiary. In diagnosis a history of exposure to T.E.L. is of great value. Determination of the Pb content of urine of exposed personnel is a valuable guide to possible intoxication, concentrations of below 0·10 mg Pb/litre are not of significance, 0·15 mg may indicate mild poisoning, and values above 0·20 show danger. Corrections for urine gravity may be necessary. If prescribed safety regulations are observed, T.E.L. poisoning will be obviated, since the dangers are well understood, continuous supervision is, however, essential. Treatment of mild poisoning cases is by removal from exposure and sedatives. Severe cases require expert nursing, in view of the acute mental symptoms present. If recovery occurs it is complete, with no permanent after-effects. V. B.

# Products.

## Chemistry and Physics.

**1405. Boiling Points of Three Isomeric Heptanes.** F. S. Fawcett. *Industr. Engng Chem.*, 1946, **38**, 338–340.—Boiling points of 2 : 2-dimethylpentane, 2 : 4-dimethylpentane, and 2 : 2 : 3-trimethylbutane have been determined by the comparative dynamic method over the range 1–15 atm, using *n*-heptane as the reference liquid. A. W.

**1406. Energy Levels and Thermodynamic Functions for Molecules with Internal Rotation. II. Unsymmetrical Tops Attached to a Rigid Frame.** K. S. Pitzer. *J. Chem. phys.*, 1946, **14**, 239.—The formulas derived in this paper make the equations and the tables given in the first paper of this series (*J. Chem. phys.*, 1942, **10**, 428) applicable to this more general class of molecules. Additional approximations are involved and carefully examined. J. T.

**1407. Statistical Mechanics of Multimolecular Adsorption. I.** T. L. Hill. *J. Chem. phys.*, 1946, **14**, 263.—Cassie's statistical treatment of multimolecular adsorption on a free surface, leading to the BET equation, is criticized and corrected. The method is generalized to include adsorption when the maximum number of layers of adsorbate is restricted. The isotherm equation obtained is the same as that found by Brunauer, Emmett, and Teller for this case, rather than the equation proposed by Pickett. The BET equation, though not completely satisfactory, is apparently the correct equation for the particular model used. Real improvements in the theory should follow from refinements in the model rather than from modification in the treatment of the BET model. A more refined model is proposed, and the general method of using it is discussed. The BET model is shown to be a crude special case of the model suggested here, but it has the advantage of presenting no mathematical difficulties. Preliminary results, based on improved models, indicate that a somewhat refined multimolecular adsorption theory is capable of predicting capillary condensation for suitable values of parameters, thus suggesting that the ideas of multimolecular adsorption and capillary condensation are not really in conflict, as is generally assumed. J. T.

**1408. Theory of Multimolecular Adsorption from a Mixture of Gases.** T. L. Hill. *J. Chem. phys.*, 1946, **14**, 268.—The Brunauer–Emmett–Teller Theory of multi-

molecular adsorption is extended to mixtures of gases. This is achieved by making use of the evaporation–condensation properties of liquid mixtures. At the present time there are no satisfactory experimental data available with which to test the theory. J. T.

**1409. The Diffusion of Vapours Through Polymers.** P. Doty. *J. Chem. phys.*, 1946, **14**, 244.—The rate of permeation of a gas through a polymer expressed as a function of temperature may be represented as $P = P_0 e^{-E/RT}$. All data on the permeability of gases through polymers show that for a given gas $\log P_0$ is linear with $E$ (the energy of activation for permeation). An explanation is given for this relationship. The effect of plasticization on permeation of water vapour is studied experimentally, and it is shown that the lowering of the heat of solution is the predominant effect. From the data the entropy of solution may be calculated and interpreted, showing that water molecules dissolved in the unplasticized polymer exhibit much less freedom than when they are dissolved in plasticized polymer. Calculations also show that a large number of degrees of freedom are simultaneously operative in the process of the diffusion of a gas molecule through a polymer. J. T.

**1410. Researches on Asphaltenes. Part II. Radical Reactions.** F. J. Nellensteyn and J. Dorleyn. *J. Inst. Petrol.*, 1946, **32**, 582–586.—The theory that asphaltic bitumen consists of a core of carbon of colloidal dimensions protected by a sheath of hydrocarbons, advanced in 1923 by Nellensteyn, is further discussed in the light of researches on the chlorination of asphaltenes. The apparatus and procedure are described. The radicles: $\dot{}CH_1$; $:CH_2$ and $\cdot CH_3$ play an important part apparently as chlorination produces $C_6Cl_6$ and $C_2Cl_4$ and other chlorinated carbon compounds. A. H. N.

**1411. Hydrocarbon Azeotropes of Benzene.** R. F. Marschner and W. P. Cropper. *Industr. Engng Chem.*, 1946, **38**, 262–268.—The azeotropic behaviour of benzene in admixture with ten non-aromatic hydrocarbons has been investigated and the entire boiling range of the hydrocarbons with which benzene forms azeotropes at atmospheric pressure has been established. Collectively, the data argue that the azeotropic behaviour of benzene is more pronounced the higher the hydrogen–carbon ratio of the second hydrocarbon component. Benzene is a much weaker azeotrope-forming substance than is ethanol, with which saturated hydrocarbons of nearly four times the boiling point spread form azeotropes. Fractionation data are presented to indicate the limitations imposed by the presence of benzene on analytical hydrocarbon fractionation, but the usefulness in certain cases of benzene as an azeotropic agent is also demonstrated. Correlations are developed by means of which the compositions and boiling points of uninvestigated benzene–non-aromatic hydrocarbon azeotropes may be estimated. A. W.

**1412. The Thermal Conductivities of Eight Common Gases between 80° and 380° K.** H. L. Johnston and E. R. Grilly. *J. Chem. phys.*, 1946, **14**, 233.—Thermal conductivities of $O_2$, $N_2$, CO, NO, $H_2$, He, $N_2O$, $CO_2$, and $CH_4$ have been measured between 80° and 380° K with a hot wire cell of potential lead type developed by Taylor and Johnston. The results generally have a precision of better than 0·1% and are believed to be accurate to $\pm 0{\cdot}5\%$. These are tabulated for the eight gases and are compared with the results of other investigators. J. T.

**1413. Temperature-Density Relation for Gasoline-Range Hydrocarbons.** J. Griswold and J. N. Chew. *Industr. Engng Chem.*, 1946, **38**, 364–367.—The temperature coefficient of density ($\alpha$) in the equation, $d_4^t = d_4^{20} + \alpha(t - 20)$, for pure hydrocarbons from $C_5$ to $C_{12}$ is correlated with hydrocarbon type and molecular weight ($M$) at temperatures near 20° C by the formula, $-\alpha = m(1/M - 0{\cdot}002) + 6 \times 10^{-4}$, where $m$ is a constant depending only on hydrocarbon type. This permits an exact conversion of $d_4^{20}$ to A.P.I. gravity whenever the type of compound is known. For application to wider temperature ranges, values of $\beta$ in the equation, $d_4^t = d_4^{20} + \alpha(t-20) + \beta(t-20)^2$, are calculated for a few compounds on which data of sufficient accuracy and range are available. The values of $\beta$ vary with structure in an unknown manner. A. W.

**1414. The Knowledge of Carbon Rings (Part 40). The Melting Points of the Polymethylene Series of Hydrocarbons from *cyclo*-Propane to *cyclo*-Octadecane.** L. Ruzicka, Pl. A. Plattner, and H. Wild. *Helv. Chim. Acta*, 1946, **29**, 1611–1615.—In the *n*-paraffin series the m.p.'s increase rapidly for the lower members, approaching a limiting value ($\alpha s + 30°$ C) for the higher members. There are two curves (one for the hydrocarbons having an odd number of C atoms, and the other for the even-numbered chains), uniting at approximately $C_{16}$–$C_{18}$. The curve for the odd-numbered paraffins is the lower, because these hydrocarbons are less symmetrical, the only exception being methane, which has a relatively high m. p. by virtue of its symmetry.

For the *cyclo*paraffins the m. p./C atoms curve is less regular. Rings having an odd number of C atoms do not always have relatively low m. p., and only compounds with seven-, eleven-, and thirteen-membered rings (*i.e.*, prime numbers) melt noticeably lower than their neighbours. *cyclo*Pentadecane ($5 \times 3$) is at a maximum on the curve and *cyclo*nonane ($3 \times 3$) has also a relatively high m. p. The most marked maxima occur with *cyclo*hexane ($2 \times 3$), *cyclo*-octane ($2 \times 2 \times 2$) and *cyclo*dodecane ($2 \times 2 \times 3$), exemplifying the known fact that the m. p. of organic compounds are greatly dependent on symmetry.

On the basis of the m.-p. curve the *cyclo*paraffins can be divided into three groups: (i) small rings ($C_3 - C_5$), a special case, perhaps, since there is abnormal bond strain, (ii) medium rings ($C_6 - C_{11}$), rigid, three-dimensional systems with similar bond-lengths and crystallizing in spherical aggregates, and (iii) large rings ($C_{12}$ upwards), less rigid, elongated systems, which crystallize in long needles and approach the *n*-paraffins with increasing molecular weight. C. N. T.

**1415. Vapour-Liquid Equilibria in Three Hydrogen-Paraffin Systems.** M. R. Dean and J. W. Tooke. *Industr. Engng Chem.*, 1946, **38**, 389–393.—The solubilities of hydrogen in *iso*butane were determined for temperatures from 100° to 250° F and pressures from 500 to 3000 psi. Solubilities in 2 : 2 : 4-trimethylpentane were found for temperatures from 100° to 302·5° F and in a mixture of isomeric dodecanes for 200° and 300° F with pressures ranging from 500 to 5000 psi. The compositions of the equilibrium vapour phases were also determined. The solubility of hydrogen increases with temperature and pressure, but decreases as the solvent molecular weight increases. In *iso*butane the solubility of hydrogen follows Henry's law only at 150° F and lower. The hydrogen solubilities in the two heavier hydrocarbons increase more rapidly with pressure at low pressures than at high pressures. Correlation with literature data shows that hydrogen is more soluble in paraffins than in aromatics of similar molecular weight. Vaporization equilibrium constants are computed from the data for both solvent and solute. The constants vary widely with pressure and to a lesser degree with temperature. The constant for hydrogen increases with an increase in solvent molecular weight. A. W.

## Analysis and Testing.

**1416. Cracking of Heavy Fractions on Hot Metal.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (160), 15.—Experiments carried out on cracking petroleum distillates on electrically heated metal spirals have established that a gas is produced identical to that from paraffin wax. The yield of gas per unit of consumed energy is low. D. H. McL.

**1417. Viscosity Characteristics of Greases.** V. P. Varentzov. *Petroleum*, Aug. 1946, **8** (9), 184.—See Abstract No. 1054 of 1945.

**1418. Viscosity Characteristics of Greases. 2. Nature of Grease Flow.** V. P. Varentzov. *Petroleum*, Sept. 1946, **9** (9), 206.—See Abstract No. 1054 of 1945. K. C. G. K.

**1419. An Improved Hot Wire Cell for Accurate Measurements of Thermal Conductivities of Gases over a Wide Temperature Range. Results with Air between 87° and 375° K.** W. J. Taylor and H. L. Johnston. *J. Chem. phys.*, 1946, **14**, 219.—Description of an improved hot wire cell of the potential lead type is given together with theoretical treatments for radiation, end conduction, potential lead conduction, and the "temperature jump" effect. The latter can be eliminated by linear extrapolation of reciprocal plots of "apparent conductivities" as a function of pressure. At pressures

below about 20 cm of mercury the convection effects are absent. The emissivity from bright platinum was measured. The thermal conductivity of air was measured at seventeen temperatures between 87° and 375° K, and the results, which are believed to be accurate to within $\pm 0{\cdot}5\%$, are generally lower than those reported in recent years, for air. A tabulation of results together with a critical analysis of possible sources of error is given. The advantage of this method over either the "thick wire" or "compensating lead" type of cells is pointed out. J. T.

## Engine Fuels.

**1420. British Aviation Fuel Manufacture—Middle East—III.** Anon. *Industr. Chem.*, 1946, **22**, 586–600.—This paper lists the extensions to existing plant, and new plant which was installed when availability of shipping made this possible. The extensions were mainly in the field of alkylation, superfractionation, and solvent extraction, but auxiliary plant, such as acid washing, recovery and production, and tankage, had to be increased. Some indication is given of the factors taken into account in planning. In less than six years production increased from 29,000 tons/annum of medium quality fuel to the finally attained rate of 1,160,000 tons of 100–130 grade (plus 90 grade) aviation gasolines. An expenditure of $50 millions in the U.S.A. was involved. F. S. A.

## Gas Oil and Fuel Oil.

**1421. Fuel-Oil and Oil Firing.** G. J. Gollin. *Heating and Ventilating Engr*, 1946, **19**, 276.—This is the first of a series of articles dealing with the industrial application of fuel oil.

As an introduction, a general description is given of the chemical composition of the three main families of hydrocarbons in petroleum oil. Diagrams of the molecular structure of the aliphatic, aromatic, and naphthenic hydrocarbons are shown.

Refinery processes in broad principle are illustrated showing how gasoline, kerosine, diesel, and fuel oils are obtained from the crude oil. J. N.

**1422. Fuel-Oil and Oil Firing.** G. J. Gollin. *Heating and Ventilating Engr*, 1946, **19**, 324.—A brief explanation of the process of combustion of fuel oil is given.

There are three main ways in which fuel may be wasted by burning it inefficiently. They may be due to poor oil-burning equipment, incorrect operation of the equipment, or a combination of both. Sources of waste are: (*a*) Unburnt carbon in products of combustion; (*b*) Carbon incompletely burnt, *i.e.*, combining with oxygen to form carbon monoxide; (c) Too much excess air. Efficient oil-burning equipment should operate with excess air only 10–20% above theoretical.

Tables and graphs are given showing typical analyses of flue gases as they vary with percentage of excess air. Flame temperature, thermal dissociation, and radiation losses are also discussed. J. N.

**1423. Fuel-Oil and Oil Firing.** G. J. Gollin. *Heating and Ventilating Engr*, 1946, **19**, 386.—This is the third article of the series, and in it the author discusses the significance to the purchaser of certain physical characteristics of fuel oil.

Methods of measurement of viscosity, gravity, and calorific value are outlined, and conversion tables for viscosity and gravity are illustrated.

Ash content is of lesser importance. Fuel oil ash contents vary from 0·01 to 0·15% compared with 2% to over 10% for solid fuels. Provided oil-burning equipment is correctly adjusted and refractory linings installed in the right manner, there should be no appreciable fouling of boiler-heating surfaces. J. N.

**1424. Fuel-Oil and Oil Firing.** G. J. Gollin. *Heating and Ventilating Engr*, 1946, **19**, 422.—This article describes various designs of oil-burners used in boilers and industrial furnaces.

The function of an oil-burner is to deliver the fuel into the combustion chamber in a finely divided state, the process commonly being referred to as atomization.

Burners used for such purposes are known as blast-burners, and may be divided into three main types, according to the pressure of the atomizing medium. These

are low-pressure, 6–30 in water-gauge; medium-pressure, from 3 lb/sq. in. to 15 lb/sq. in., and high-pressure, from 15 lb/sq. in. upwards.

For low- and medium-pressure blast atomizers air is usually employed as the atomizing medium, while in the case of high-pressure, steam is normally used.

Different methods used by different manufacturers are described with illustrations of each type. J. N.

**1425. Fuel-Oil and Oil Firing.** G. J. Gollin. *Heating and Ventilating Engr*, 1946, **19**, 461.—In the fifth article of this series the author continues the description given in the fourth article on burners. Additional type of blast-burners are described, and details of the principle of pressure jet atomizers are given.

This latter type is used in nearly all ships' boilers and is widely employed in large power-station work.

The advantages and disadvantages of each type and the factors governing the selection of burners are discussed. J. N.

**1426. Fuel-Oil and Oil Firing.** G. J. Gollin. *Heating and Ventilating Engr*, 1946, **19**, 507.—Types of vaporizing burners and principle of operation are discussed and illustrated in this article.

Vaporizing burners are so called because there is no attempt to atomize the oil before burning. The oil is heated, vaporizing the greater part of it, the vapour being subsequently mixed with the correct amount of air and burnt.

There are very definite limits to the grades of oil which may be used on burners of this type, the most important characteristics being distillation range and the Conradson carbon value.

The significance of each of these characteristics is explained.

General arrangements of oil-burning installations are illustrated and filling and storage systems described. J. N.

## Lubricants.

**1427. Developments in Lubrication (1).** S. J. M. Auld. *Petroleum*, Aug. 1946, **8** (9), 190.—The first part of a lecture discussing the principles of lubrication, the use of additives, and the manufacture of synthetic lubricants. K. C. G. K.

**1428. Developments in Lubrication (2).** S. J. M. Auld. *Petroleum*, Sept. 1946, **9** (9), 211–212.—The second part of a lecture on the principles of lubrication, the use of additives and the manufacture of synthetic lubricants. K. C. G. K.

**1429. Lubrication Vade Mecum Addendum (6).** E. W. Steinitz. *Petroleum*, Aug. 1946, **8** (9), 195.—The lubrication of passenger motor cars, motor lorries, motor cycles and tramway cars is dealt with. K. C. G. K.

**1430. Lubrication Vade Mecum Addendum (7).** E. W. Steinitz. *Petroleum*, Sept. 1946, **9** (9), 219.—Section XI deals with the lubrication of Agricultural and Building Contractors Machinery, including: Agricultural Trailers, Farm Carts; Asphalt and Tar Mixers; Bucket Dredgers; Wheel Tractors, Caterpillar Tractors; Steam Ploughs. K. C. G. K.

**1431. Notes on New Lubricants.** C. Ridley. *Gas Oil Pwr*, 1946, **41**, 358–359.—The U.S.A. now makes and markets two types of synthetic oils. One, made from hydrocarbon gases, is said to have a negligible increase in viscosity when used in an engine, since its oxidation products are volatile. The other has a molecular structure similar to that of conventional lubricants, except that many of the carbon atoms are replaced by silicon atoms. The advantage of this synthetic are: negligible change of viscosity with temperature, good heat stability, and general chemical inertness.

It is stated that German chemists, starting from coal, can match practically every lubricant made in the U.S.A. from natural petroleum. H. C. E.

**1432. Some Observations on the Development of Extreme Pressure (E.P.) Properties by Chlorine and Sulphur Additives in Mineral Oil, as Assessed by the Four-Ball Machine.** W. Davey. *J. Inst. Petrol.*, 1946, **32**, 575–581.—The Four-Ball Machine has been used to assess the development of E.P. properties by chlorine and sulphur additives in mineral oil, and the use of these additives together for high load conditions justified. The formation of ferrous chloride films by chlorine additives has been confirmed and the effect of sulphide films and hydrogen chloride studied. A. H. N.

**1433. Role of Inertia in Hydrodynamic Lubrication.** M. C. Shaw and C. D. Strong, Jr.; Reply by A. Fogg. *Nature*, 1946, **158**, 452.—Fogg's experiments on lubrication of parallel thrust surfaces operated at high speeds give results comparable with those obtained with conventional Michell or Kingsbury type thrust-bearings. These results are explained on the basis of a temperature gradient along the film in the direction of relative motion.

A mechanical analysis of the system shows that this theory is in qualitative, but not quantitative, agreement with Fogg's experiments in that the load capacity of parallel surfaces is of the order 1/5 to 1/10 of that for an equivalent tilting-pad. The inertia of the lubricant is negligible at low, but not at high, rotative speeds. The inclusion of inertia terms in hydrodynamic equations accounts qualitatively for the observed load capacity of plane rotating discs which, in accord with the inertia theory of lubrication, can carry loads only at relatively high speeds.

A bearing designed to take advantage of inertia at all speeds gives at different speeds different curves, in agreement with the inertia theory, when coefficient of friction is plotted against $ZN/P$, where $Z$ is the viscosity of lubricant in centipoises, $N$ is the speed in R.P.M., and $P$ is the unit load on the projected area of the bearing.

(Reply by A. Fogg.) If the load capacities for parallel and tilted surfaces are compared on the basis of mean film thicknesses of lubricant the comparison is not valid, for a fixed taper surface will fail by contact at the trailing edge when the mean film thickness is comparatively large. For parallel surface thrust-bearings the curves of coefficient of friction against $ZN/P$ are substantially the same over the range 1000 to 20,000 r.p.m., and inertia has only a secondary effect. The possibility of inertia effects was examined, and rejected, before the thermal expansion theory was put forward. H. C. E.

**1434. The Influence of Oil-Film Journal Bearings on the Stability of Rotating Machines.** A. C. Hagg. *J. Appl. Mech.*, 1946, **13** (3), A-211–A-220.—The self-excited vibration caused by the lubricating films of journal bearings, and commonly called oil film whirl or oil whip, is discussed. The upper limit of whirling frequency has been found to be one-half rotational frequency in the general case; actually the phenomenon will manifest itself at a frequency which is invariably below this limit. Stability criteria have been developed for certain common systems in terms of bearing and rotor parameters. The tilting-pad bearing of Michell has been established as a so-called "stable" or "non-whirling" bearing. This bearing and related types are probably the only oil-film journal bearings which are incapable of exciting oil-whip, regardless of the system to which they are applied. Qualitatively the results of the paper appear to be in agreement with observations. In certain cases, results have been substantiated experimentally. A. H. N.

**1435. The Pressures against which Oils will Spread on Solids.** E. R. Washburn and E. A. Anderson. *J. Phys. Chem.*, 1946, **50** (5), 401–406.—The spreading tendencies of oils on steel were measured directly by utilizing the spreading pressures of monomolecular films. Lubricating oils in different degrees of oxidation were studied and, in general, the spreading pressures were found to increase—approximately being doubled on oxidation at 200° C in 4–6 hours. A. H. N.

**1436. Principles of Filtration. 1. Introduction.** A. H. Stuart. *Petroleum*, Aug. 1946, **8** (9), 193.—The rapid growth of mechanical transport has resulted in the use of many types of oil filters. This article reviews some of the general principles on which filters operate and comments on the results obtained from laboratory tests.

K. C. G. K.

**1437. Principles of Filtration. 2. Oil Cleaners.** A. H. Stuart. *Petroleum*, Sept. 1946, **9** (9), 213.—In connection with the filtration of used lubricating oil, it is important to consider the nature of the impurities found. From external sources come gases, such as oxygen and carbon dioxide, liquids, such as unburnt fuel and water or other coolant, and solids, such as iron dust, white metal particles, road dust, sand, carbon, etc. Decomposition products from the oil itself may be at least as objectionable as foreign contaminants.

The simplest type of oil-cleaning is settling under gravity. This process, however, is usually very slow. It can be accelerated by heating the oil to reduce its viscosity, by the addition of a coagulant, or by centrifuging. Filtration is the common mode of treatment. As the mesh of the sieve becomes finer, resistance to flow increases very rapidly. Thus if it is desired to remove very fine particles, the pressure drop through the filter will be considerable. Adsorbent material such as fullers' earth is employed as a filtering septum in an attempt to overcome this drawback. This latter process is not, however, a mechanical one, since certain oil-soluble resins may be retained in this way. K. C. G. K.

**1438. Machinery of Plain Bearings with Single-Point Tools.** P. Grodzinski. *Petroleum*, Aug. 1946, **8** (9), 188. 1. Lubrication Theory. The bearing theory is discussed and the difference explained between high-speed rotating diamond and tungsten carbide tools. The methods of scraping and reaming hitherto used do not yield a good bearing surface, so that long running-in periods become necessary. A short survey of modern bearing materials and their customary clearance and capacity limits is given in tabular form.

In a bearing with perfect fluid lubrication, the minimum oil-film thickness must be sufficient to prevent contact between the peaks of the journal and the bearing surfaces. Hence, the safety film thickness must be at least equal to the sum of the peaks of both journal and bearing surfaces. In 1942, B. Sacks stated that the minimum thickness of an oil film must be at least equal to $2 \times 2 \times 5\ h_{rms} = 20\ h_{rms}$, where $h_{rms}$ = average roughness is root mean square micro. in, as indicated by tracer point instruments. Surfaces of $h_{rms}$ average height of 1·4 micro. in can be produced commercially at the present time, so that it may be possible to go down to a minimum oil-film thickness of between 40 and 80 micro. in, *i.e.*, 1/10 to 1/5 of the values in use about 12 years ago. K. C. G. K.

**1439. Machining of Plain Bearings with Single-Point Tools 2. Bearing Theory.** P. Grodzinski. *Petroleum*, Sept. 1946, **9** (9), 214.—Bearing theory is discussed in relation to surface structure. The merits and uses of diamond and tungsten carbide tools are examined. K. C. G. K.

**1440. Steam-Turbine Lubrication Problems and their Solutions.** A. Wolf. *Petroleum*, Aug. 1946, **8** (9), 183.—Former literature on turbine lubrication indicated that faulty lubrication, excessive oil deterioration, formation of obstructive deposits, etc., was invariably shown, particularly in the early stages, by increase in the bearing temperatures, oil-cooler outlet, water temperature, etc. Rusting or corrosion of ferrous surfaces, or increasing sluggishness, and even sticking of oil-operated relay mechanisms in large turbines, was neglected, although this may cause the speed governor to stick when the load is removed, with consequent danger of the rotor flying apart. In practice, such serious defects may not be shown up by any marked rise in oil-bearing or cooler outlet water temperatures. This applies particularly to uninhibited, highly solvent refined turbine oils derived from naphthenic crudes.

Any corrosion of ferrous surfaces is not seen on ordinary visual inspection. Corrosion of non-ferrous surfaces does not as a rule occur until the oil has reached a very advanced stage of oxidation. In moderate and high-temperature turbines, while the temperature of the return oil from each bearing may be of the order of, say, 140° F, the temperature of the oil-skin in immediate contact with the rotor journal must be far higher when the unit is operated by steam, superheated perhaps to any temperature up to 1000° F or over. This skin temperature is one of the main factors determining the rate of oxidation of the oil. To diminish its effects, it is very important to ensure that the flow of cool oil through the bearings and over the portions

of the rotor shaft also within the bearing housings, but projecting from the bearings shall be as uniform as possible, to avoid all risk of the development of local "hot spots." Bearing return temperatures are also of great importance, and should be logged at least daily. The engine-room temperature should be taken and recorded at the same time, and the difference carefully observed. It should be constant for each bearing (making allowance for any variations in the temperature of the oil leaving the cooler). Any increase in the case of individual bearings indicates an abnormal condition.

There is undoubtedly a general trend for uninhibited oil life to be shortened by abnormally high oil temperatures. This tendency is little if at all evident with efficiently inhibited oils. It must be emphasized, however, that uninhibited turbine oils, especially of the highly solvent-refined type derived from naphthenic base stocks, may deteriorate very rapidly, even if the oil temperatures in every portion of the lubricating system are perfectly normal and have remained constant over a long period. K. C. G. K.

**1441. Steam Turbine Lubrication Problems and their Solutions. 2 (2) Effect of Steam Temperature on Oil Oxidation.** A. Wolf. *Petroleum*, Sept. 1946, **9** (9), 203.—A portable mercury thermometer of range, say, 20–220° F is very useful in carrying out turbine lubrication surveys. Details are given of the positioning of the thermometer bulb so as to ensure reliable readings.

The view that turbines should present no lubrication difficulties, even when driven by highly superheated steam at high pressures, is based on the moderate level of bulk oil temperatures and the assumption that steam does not come into direct contact with the oil, because the turbine casing is separated by an open space from the bearing housing, and both are provided with glands and seals. However, present high steam pressures and high-speed rotors make it difficult to design steam-tight glands, and have brought about a reduction in the distance between the rotor bearing centres. Leaking superheated steam is invisible, but may be detected by its charring effect on paper. Any such superheated steam-jet contacting the oil-sealing rings of the bearing housing will enter and form an emulsion as soon as the steam temperature falls below 212° F.

It is probable that most oil-oxidation occurs in the bearing-housings, particularly at the high-temperature end of the turbine. Due to aeration of the oil and a possible vacuum ejecter effect produced by the escape of oil from the bearing housing via the vertical oil return pipes, the oxygen supply is continuous, so that oxidation does not slow down as might be expected.

In addition to lubrication and providing fluid pressure, the oil plays an important function in removing heat from the bearings. K. C. G. K.

**1442. Phenomena in the Oil Insulation of Pressurized Electric Cables.** C. F. Proos. *Ingenieur*, 1946, **58** E, 65–70.—Continuing the previous study (see Abstract No. 987), measurements were carried out on the effect of overloading a pressurized cable. Overloading at room temperature did not effect the insulation. Measurements after a heat treatment (1000–3000 hours at 60–75° C) indicated larger dielectric losses (*tg.* $\delta$) at low loads than at high loads.

It would appear that the method of testing could be used for evaluating the properties of various oils and methods of cable construction.

The general conclusion is that the insulating properties of the oil should preferably be independent of electric load at high temperatures. In addition, the oil and the other insulating materials should have a good oxidation stability. M. B.

## Bitumen, Asphalt and Tar.

**1443. Base Design for Bituminous Roads.** L. D. Hicks. *Roads and Streets*, Aug. 1946, **89** (8), 103.—Recommended base and sub-base thicknesses beneath 1-inch bituminous surface treatment for various wheel loads in North Carolina are given. A series of tables list various types of loads, and thicknesses for subgrade bearing values of 30, 20, 15, and 10 p.s.i. serving under maximum axle loads of 8000 to 20,000 lb. G. A. C.

**1444. A Study of Bituminous-Coated Corrugated Sheet-Metal Culverts.** J. Y. Welborn and P. J. Serafin. *Public Roads*, 1946, **22** (9), 227.—The field inspection of culvert pipe installed for the drainage of surface water and laboratory analyses of the samples taken are described.

The metal pipe had been in service from 4 to 9 years. Three general types of bituminous-coated sheet metal pipe are used. Galvanized metal pipe coated with asphalt and with an asphalt pavement consists of corrugated sheet-metal piping uniformly coated with asphalt inside and out, and the section of the inside circumference which forms the bottom of the pipe when installed is coated with an additional thickness of asphalt such that the corrugations are filled and a smooth pavement formed. A second type is asbestos-bonded metal pipe coated with asphalt and with an asphalt pavement, a layer of asbestos felt being rolled into the molten spelter coating on one side of the sheet, and after the surface is primed with a bituminous material the sheets are fabricated into corrugated pipe. The asphalt pavement is formed as for the plain pipe. The third type is a galvanized corrugated pipe coated on the outside and three-fourths of the inside with asphalt; the remaining fourth, which forms the bottom of the pipe, is paved with asphalt reinforced with metal.

The data from the inspection report for each culvert were tabulated, and an explanation of the terms good, checked, cracked, broken, loss, adhesion, and flow are given in the article.

From the data obtained it was concluded that in general the most severe deterioration of the asphalt coating and pavement was found at the outlet ends of the pipes, and the amount of flow of water did not bear any consistent relation to the degree of deterioration, nor had the slope of the pipe much influence. The outside asphalt coating was usually checked, and had very little adhesion to the metal. Metal-reinforced asphalt-paved inverts showed the greatest amount of deterioration, and asbestos-bonded metal had the greatest resistance to deterioration. The durability of the coating depends largely on the type of asphalt used. G. A. C.

**1445. Soil Compaction, Moisture and Bearing Value.** A. H. Gawith. *J. Inst. Engrs Australia*, 1946, **18**, 109.—Recent advances in the knowledge of the influence of seasonal changes and variations in height of ground-water table on the stability of the soil are dealt with, and results are given of an investigation of roads in a particular locality.

The degree of compaction of the soil being produced by some compacting process which breaks down the larger secondary particles can be defined either in absolute or relative terms. Two methods exist to determine the compaction, the Proctor and the Modified A.A.S.H.O. Compaction tests, which obtain the percentage of the dry weight per cubic foot which can be obtained by ramming at the most favourable moisture content under the conditions specified for the particular test.

Compaction to high densities will reduce the moisture content attained by the material under saturation conditions, and swelling is influenced by the moisture content and surcharge of sand or other granular material.

The moisture content of a soil is modified by several factors, including non-uniformity of temperature and texture, rain falling on the surface soil, and cracks in the soil column.

Darcy's law for the movement of water and for unsaturated flow is stated, and from Russian experiments some indication of the possible rates of upward movement of water has been deduced. Three cases are discussed on the behaviour of water in the soil under a pavement for varying water-tables, and the moisture content for four individual soils are tabulated. Field tests included observations of moisture conditions under light sealed pavements in Victoria, where the average annual rainfall is 17 inches. Values of liquid limit varying from 43 to 66% and of Plastic Limit 15 to 21·2% were encountered with soil-moisture contents from 6 to 29·5%.

The California Bearing Ratio test was applied to a limited number of large samples, and a chart shows the relation between this ratio and the resistance to penetration of a Proctor needle.

From the data obtained it is considered that it is only on account of the low rainfall and high rate of evaporation in these semi-arid areas that it has been possible to use the very thin pavements with some degree of success.

Failures and longitudinal cracks generally nearer the pavement edges occurred, probably caused by lower bearing value of the soil at the edges. G. A. C.

## Special Hydrocarbon Products.

**1446. Crystallography of Waxes and Related Substances. 3(2). Photomicrographs.** L. Ivanovsky and J. H. Wredden. *Petroleum*, Sept. 1946, **9** (9), 218.—Six further micrographs are shown of crude, yellow, and white Russian ozokerites. K. C. G. K.

**1447. Plastics from Petroleum. 3(2). Production.** W. S. Penn. *Petroleum*, Aug. 1946, **8** (9), 186.—All thermosetting plastics requiring the use of formaldehyde can have the latter component derived from petroleum. Allyl plastics are obtainable from petroleum via propylene.

The synthetic elastomers probably absorb the largest quantity of petroleum products used for making chemicals. There is no doubt that fairly large quantities of some synthetic rubbers will continue to be made even when natural rubber once more becomes freely available.

At present the most important is undoubtedly GR–S, the butadiene–styrene copolymer. The manufacture of styrene has already been described. Butadiene may be obtained by several alternative routes. Perbunan types are obtained from butadiene and acrylonitrile. Butyl rubber is produced by copolymerization of *iso*butylene and *iso*prene on butadiene. Neoprene is made by polymerizing chloroprene, which is made from acetylene.

Thiokols are made by heating sodium polysulphides with ethylene halides.

Various solvents and plasticizers can also be made from petroleum. If certain chemicals could also be produced from petroleum in large quantities, the use of petroleum in the field of plastics would be even more important. One such chemical is butadiene, the roundabout production of which from aldol is awkward and costly. It is also important to produce more benzene and other aromatics from petroleum.

As regards the post-war demand for synthetic rubbers, the question of GR–S, the general purpose synthetic rubber, is the most prominent. GR–S is not as good, in its present form, as natural rubber, and will be almost completely replaced. Later, of course, improved polymers may be developed. The demand for other synthetic rubbers (perbunan, neoprene, thiokol) is not likely to diminish to any extent, and may even increase because of their ozone and oil-resistance. The situation for P.V.C. is similar, where it has been used for special purposes. K. C. G. K.

## Derived Chemical Products.

**1448. Synthesis of the Base $C_{14}H_{25}N$ of California Petroleum.** V. Prelog and U. Geyer. *Helv. Chim. Acta*, 1946, **29**, 1587–1603.—Three nitrogen bases of similar constitution have been synthesized and examined. One of these, 2 : 4-dimethyl-6-(*trans*-2 : 2 : 6-trimethyl*cyclo*hexyl)-pyridine, has been shown, from a consideration of the ultraviolet absorption spectra, densities, refractive indices, molecular refractions, and properties of the picrates and picrolonates, to be identical with the nitrogen base, $C_{14}H_{25}N$, isolated from California petroleum by W. C. Thompson and J. R. Bailey (*J. Amer. Chem. Soc.*, 1931, **53**, 1002–1011). The structure of this base was previously shown by B. Shive, S. M. Roberts, R. I. Mahan, and J. R. Bailey (*ibid.*, 1942, **64**, 909–912) to be 2-(2 : 2 : 6-trimethyl*cyclo*hexyl)-4 : 6-dimethylpyridine. C. N. T.

## Miscellaneous Products.

**1449. Colloidal Carbon.** W. H. Cadman. *Petrol. Times*, 31.8.46, **50** (1281), 898.—An abridged form of an extensive paper by the author presented before the Royal Society of Arts. It deals with many aspects of colloidal carbon production, properties, and uses. Natural gas is the raw material which is by far the most extensively used in the production of colloidal carbon. Other raw materials include waste refinery gases and various coal products. R. B. S.

**1450. Liquid Methane as a Motor Fuel. 1. Supplies and Properties.** R. M. Bridgwater. *Petroleum*, Aug. 1946, **8** (9), 194.—The possibility of using methane as a motor fuel is of interest to the petroleum industry for two reasons. Firstly, it affords a means of which Britain can make use of an efficient substitute for imported fuel.

Secondly, in countries amply endowed with petroleum there is usually a large quantity of natural gas available which may be used to conserve petroleum supplies.

Supplies which could be used without affecting other existing processes are: natural gas, mines gas, sewage gas and surplus coke-oven gas. These supplies are not large and are not always in places convenient for use. Sources of natural gas in this country are small.

The difficulty with the use of coke-oven gas as a source of liquid methane is that it contains only 25–30%. Conversion of the carbon monoxide and hydrogen in the gas into methane catalytically has not yet reached the stage of being a commercial proposition.

Potential sources of methane oil: as a by-product in petroleum refining, the hydrogenation of coal and oil and the Fischer–Tropsch and related syntheses. Little is available in Great Britain at present from such sources, however.

The properties of methane make it very suitable for use in internal-combustion engines. It is best transported in liquid form. One pound of methane has a calorific value 14% higher than the same weight of gasoline. Because of density considerations, however, its calorific value on a volume basis is 34% less than that of gasoline. Methane has excellent anti-knock properties as well as various other advantages.

K. C. G. K.

**1451. Phase Relations in the System: Sodium Stearate-Cetane.** T. M. Doscher and R. D. Vold. *J. Colloid Sci.*, 1946, **1**, 299–312.—The binary system sodium stearate–cetane is examined between crossed Nicols at temperatures between 20° C and $T_t$, the temperature at which an isotropic liquid is formed. The following observations were made:—

20–110° C. Curd fibres (dark irregular strings) and waxy phases (dark stippled areas) are first seen. With increase in temperature the former vanish, and subsequently liquid separates out.

110–120° C. The appearance of the material at this stage is a function of soap content:

Above 75% soap, the liquid is reabsorbed immediately. As the soap concentration decreases the waxy phase is transformed to a brilliant uniform "superwaxy" phase.

Between 75% and 57% soap, free liquid is reabsorbed on holding the temperature constant for up to 2 hours. Transitory structured areas appear in the isotropic phase, but are not seen if the rate of heating is rapid.

Between 57% and 40% soap, free liquid is reabsorbed as above, but the structured areas are more permanent.

Below 40% soap, free liquid is never completely reabsorbed. With decreasing soap content the structured areas eventually appear as an isotropic material which below 20% soap forms irregularly outlined rods of a palisadic type of structure.

120° C to $T_t$. At high soap content a coarsening of the field is suggestive of the formation of crystallites. As the soap content decreases this effect is missing, $T_t$ falls, and the superwaxy phase predominates. A phase diagram of the system is given.

In discussing these changes, the authors suggest that the curd fibre phase is a disordered array of crystallites of sodium stearate bound by intermolecular forces, a weakening of which results in the formation of waxy phases. It is deduced that cetane dissolves between the soap chains, with eventual formation of superwaxy soap. This hypothesis accounts for the non-smectic character of the superwaxy phase, since the inclusion of cetane molecules between the chains of the soap lattice when the attractive forces of the polar heads is still high will deform the parallel character of the lattice and prevent the formation of a smectic phase. The appearance of a smectic phase at lower temperatures and high cetane concentration is explained by the assumption that still more cetane molecules overcome the polar forces to give a loose structure in which the tails of the soap molecules are again parallel.

H. C. E.

**1452. Secrets of German Fuel Technology Unearthed.** Anon. *Petrol. Times*, 14.9.46, 50 (1282), 966.—The following C.I.O.S., B.I.O.S., and F.I.A.T. Final Reports are briefly reviewed:

B.I.O.S. Final Report No. 513. Notes on the Organization of the German Petroleum Industry during the War (14 pages).

B.I.O.S. Final Report No. 507. Coal Tar Distillation, Chlorinated Phenols, Phenol Formaldehyde Resins, and Synthetic Phenols (24 pages). H.M.S.O. 3s. (post 2d.).

B.I.O.S. Final Report No. 510. Samples of Petroleum Products Collected from the Hamburg, Hannover, Bremen, and Kiel Area (38 pages). H.M.S.O. 3s. 6d. (post 2d.).

B.I.O.S. Final Report No. 511. Ruhr Chemie A.G. Sterkrade-Holten: Interrogation of Dr. O. Roelen (25 pages). H.M.S.O. 2s. 6d. (post 2d.)—Contains reports on translations of three documents prepared by Dr. Roelen of Ruhr Chemie A.G., viz.:—

I.—The Fischer-Tropsch Process and its Products.

II.—Synthetic lubricants made by the Ruhr Chemie A.G.

III.—Town Gas and Methanised Air for Automotive Propulsion.

B.I.O.S. Final Report No. 512. Schlafhorst Chemische Werke G.m.b.H., Hamburg, Germany: Lubricants (15 pages). H.M.S.O. 1s. 6d. (post 1d.).

F.I.A.T. Final Report No. 90. Interrogation of Professor Franz Fischer (3 pages)—Contains reports on information given from memory by Professor Fischer on *iso*-synthesis, iron synthesis, nickel catalysts, suspended catalysts, and isomerization.

F.I.A.T. Final Report No. 239. Textile Auxiliary Products Manufactured by I.G. Farbenindustrie, Mainkur Works (12 pages). H.M.S.O. 6d. (post 1d.).

F.I.A.T. Final Report No. 273. Interview with Dr. J. W. Reppe, I.G. Farbenindustrie A.G. (21 pages)—Contains reports on Dr. Reppe's principal contributions to the war in the form of newly developed processes involving novel reactions of acetylenes and of metallic carbonyls.

F.I.A.T. Final Report No. 447. Study of Production of Shale Oil from Shale in Wurtemberg (99 pages).

F.I.A.T. Final Report No. 737. Economic Study of German Synthetic Waxes (32 pages). R. B. S.

## Engines and Automotive Equipment.

**1453. Use of Ether as Ignition Agent.** R. J. Bender. *Auto. Aviation Ind.*, 1.9.46, **95**, 40.—The Ring process, which the article describes, is an invention for the elimination of the sparking-plugs in an aero-engine, which are the weakest part of the engine, especially for high-altitude work. Ignition is produced by spraying into the combustion chamber at the right moment of the gasoline-air compression stroke a liquid which will ignite spontaneously at the temperature of the cylinder, thus igniting the combustible charge. The ignition liquid used, called "R-Fluid," is an ether such as butadiol diethyl ether or diethyl diglycol ether. The cetane rating of this fluid can be as high as 185. R-Fluid can be used as a starting fluid for diesel engines. The Ring process has proved to reduce the knocking tendency of a fuel, apparently due to the fact that the particles of R-Fluid penetrate the mass of air and fuel thoroughly before igniting, so that ignition is thereafter uniform throughout the cylinder charge. A saving of fuel of approximately 5% may be expected as a result of the more knock-free performance and in the lean mixture condition. Two problems in connection with the Ring Process are the problem of starting the engine, especially at low temperatures, which involves auxiliary spark-ignition equipment, and the problem of reducing the cost of installation of the necessary injection equipment. R. B. G.

**1454. Fuel Sensitivity and Engine Severity in Aircraft Engines.** S. D. Heron. *J. Soc. aut. Engrs*, 1946, **54**, 511–512.—The relation of engine severity and fuel sensitivity is discussed; recent research on hydrocarbons within the aviation gasoline boiling range reveals that there are no possible super fuels for severe engines which have high cylinder and mixture temperatures. With mild engines, performance numbers of 200–300 employing 4 cc of TEL are possible. It is suggested that a decision should be made between adopting the severe or mild engine to guide fuel producers in the production of the appropriate gasoline. G. P. K.

**1455. Airscrew Turbine Progress.** Anon. *Flight*, 31.10.46, **50** (1975), 466.—Describes development of Armstrong Siddeley Python and Mamba airscrew gas turbines. The Python has completed 25 hours running with Rotol airscrews and favoured aircraft for use as flying-test beds are the Avro Lancaster and Lincoln. The two engines

are respectively the highest-powered and smallest airscrew turbines so far announced. Development of the Mamba is not so far advanced. The gas-flow is straightened by clustering the combustion chambers between the axial-flow compressor and the turbine instead of packing them round the compressor casing, as on the Python. Total weight with airscrew is about 1000 lb, and diameter over cowling, 27 in.

The A.S.X. is being used in the development of a starter for the Python. The starter works on compressed air or a slow-burning cartridge. The intention is to use it in conjunction with a mobile ground compressor, but to carry cartridges for "unscheduled" starting. The A.S.X. runs up to 1500 r.p.m. in 30 sec using an air-pressure of 100–140 lb/sq. in. I. G. B.

**1456. Filtration for Oil Engines.** C. G. Vokes. *Gas Oil Pwr*, 1946, **41**, 347–350.—The effect of dust particles of given size on piston wear is described. For air filtration the viscous filter, the oil-bath filter, and the centrifugal cleaner are all discussed, and their advantages and disadvantages are compared. A new type of air-filter utilizes the blast from the exhaust to create an injector effect for the air-stream, from which a layer of clean air can be drawn off.

The three principal methods of oil filtration—full flow, byepass, and periodic removal of oil for external filtration—are analyzed, and faults commonly encountered in practice are pointed out. Three stages in the filtration of fuels are described.

A list of desirable characteristics of air and oil filters is given. H. C. E.

**1457. Combustion in a Precombustion-Type Diesel Engine.** H. F. Bryan. *J. Soc. aut. Engrs*, 1946, **54** (9), 449–457.—Diesel-engine combustion has been studied using a high-speed camera to photograph spray form, spray penetration, and combustion in a pressure chamber in which engine conditions could be simulated and in a single-cylinder engine with a window set in the precombustion chamber. Apparatus and results achieved are discussed. Present indications are that for best diesel performance the maximum rate of burning of fuel should occur in the last half of the combustion period, and that the position of top centre in relation to maximum rate of burning is of prime importance. G. P. K.

**1458. Theseus I.** Anon. *Flight*, 10.10.46, **50** (1972), 386.—Further details of the Bristol turbine-airscrew unit are given.

The compressor comprises nine stages of axial blading and a final centrifugal impellor giving an overall compression ratio of 5 : 1 at 300 m.p.h. at 20,000 ft. At full throttle the compressor runs at 8200 r.p.m. and delivers 30 lb/sec of air at sea-level static conditions—equivalent power input is 3500 h.p. The heat-exchanger is a matrix type unit the tubes of which are arranged in 16 sets, eight inlet and eight outlet separated by suitable headers. To mitigate differential expansion the exchanger is situated on the main engine mounting structure and located at the forward end. The first turbine (two-stage) powers the compressor and auxiliaries, and the single-stage second turbine drives the airscrew. The latter runs at 9000 r.p.m. As the speeds of the two turbines must be kept in nearly constant ratio, a governor mechanism is incorporated whereby the airscrew blade pitch is automatically controlled. The reduction gear incorporates four sets of compound planet wheels and the ratio is 8·4 : 1. I. G. B.

**1459. Reliability of Gas Turbines.** Anon. *Flight*, 17.10.46, **50** (1793), 426.—Rolls Royce give details of performance testing of a Series I Derwent engine. Originally assembled in June 1944, it has run a total of 1005 hours, 920 hours of this being at full type test conditions. After 500 hours replacements needed were a set of flame tubes, one air-casing, some turbine blades, and a fuel-pump. Major components still in use are the wheel-case with accessory drives, the compressor impellor and shafts; the compressor casing, diffuser, and combustion chambers.

In R.A.F. service the running period of 180 hours has recently been increased to 270 hours. Present practice is to increase the overhaul period in stages of 90 hours and a further extension of 90 hours is expected to be granted for the Derwent I.

I. G. B.

**1460. Hydraulic Power a Growing Avenue for Petroleum.** C. Ridley. *Petrol. Times*, 31.8.46, **50** (1281), 920.—The use of hydrocarbon fluids in hydraulic controls and transmissions, hydraulic lifts, fluid flywheels, and torque converters, hydraulic springing, and as hydraulic fluids for other purposes, is discussed. The advantages of these drives over mechanical units, especially in reducing the complexity of design, are also outlined. R. B. S.

## MISCELLANEOUS.

**1461. Liquid Methane as a Motor Fuel 2. Carriage of Methane.** R. M. Bridgwater. *Petroleum*, Sept. 1946, **9** (9), 216.—The best way of carrying gaseous methane is compressed in cylinders. Data are given for the weight of equipment and the possible mileage in the case of a 5-ton lorry operating on various alternative fuels. It is seen that liquid methane comes next to petrol as regards general performance. Its disadvantage is that it so readily evaporates, necessitating careful design of equipment. Various ways of delivering liquid methane to the engine are also discussed. K. C. G. K.

**1462. World Refinery Construction Enters New Stage of Expansion.** Anon. *World Petrol.*, 1946, **17** (8), 78–81.—The expected post-war decline in refining and production equipment has been much less severe than was anticipated. This fact, together with the improvization effected as a war-time measure, has led to many new installations. The major projects of the world are reviewed, together with the measures to reconstruct those plants which have suffered through war, especially in the Far East and Europe. F. S. A.

**1463. Reconstruction of the East Indies.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (160), 14.—A summary of the present position of the petroleum industry in the East Indies. D. H. McL.

**1464. German Production and Refining in the British Zone.** Anon. *Petrol. Times*, 31.8.46, **50** (1281), 912.—Statistical data are presented on the production of north German oilfields for the last six months of 1945 and the first six months of 1946. The monthly output of refineries and products for the same period are also tabulated. R. B. S.

**1465. A British Refinery in War-time.** Anon. *World Petrol.*, 1946, **17** (8), 71–73.—An account is given of the war-time activities of Manchester Oil Refineries, Ltd. The paper includes a list of their products. F. S. A.

**1466. British Refining Adjusted to Peace-Time Demands.** A. H. Day. *World Petrol.*, 1946, **17** (9), 41–43.—In order to economize on shipping space and labour, import of crude fell by 75% during 1938–43, but total petroleum imports increased by 25% due to import of refined products. Some details are given of the changes made to effect reduction in home refining. Brief argument is advanced concerning the relative merits of continuing this policy or of expanding domestic refinery activities. It is stated that Britain is reverting to pre-war industrial production and that her oil requirements are the same as previously, except that the Government is the sole purchaser. F. S. A.

**1467. United Kingdom Petroleum Imports in July and the Seven Months.** Anon. *Petrol. Times*, 31.8.46, **50** (1281), 923.—Statistical data on imports and exports (including oil fuel bunkering of shipping) of crude oil and refined products for July and the first seven months of 1946 are presented, together with comparative figures for 1945 and 1938. R. B. S.

**1468. U.K. Import Trade of Solid Petroleum Products in War-time.** Anon. *Petrol. Times*, 14.9.46, **50** (1282), 952.—The war-time decline in the imports of solid petroleum

products into the U.K. is illustrated by statistical data on these imports, both by imported products and by countries of consignment, for the years 1938–1945 inclusive.
R. B. S.

1469. **Hungarian Oil.** M. Freund. *Petroleum*, 1946, **9** (9), 204.—A survey of oil production and refining in Hungary. Tables indicate crude oil and natural gas production for the years 1937–1945 and also show the capacities of Hungarian refineries (before war damage) and analytical data for Hungarian crudes. K. C. G. K.

1470. **Dictionary of Italian Technical Terms relating to the Petroleum Industry.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (160), 18.—Continued from the June 1946 issue of this journal, the dictionary gives English, French, and German equivalents of technical terms relating to petroleum technology. D. H. McL.

1471. **Palestine Petroleum Imports and Exports in 1945.** Anon. *Petrol. Times*, 31.8.46, **50** (1281), 914.—Statistical data are presented on the imports and exports of crude oil and refined products for 1945 with comparative figures for 1944, 1943, and 1938. R. B. S.

1472. **Deficiency of Combustible Liquids in Roumania.** Anon. *Riv. Ital. Petrol.*, 1946, **14** (160), 13.—Roumania is suffering from a grave deficiency of heavy oils for internal industry. The government has authorized the sale of a mixture of 60% kerosine, 10% gas oil and 30% residual asphalts, whilst the manufacture of asphalts has been prohibited to encourage the production of this mixture. The actual deficiency, which amounts to at least 30,000 metric tons per month, is the result of reparations and sales to U.S.S.R. D. H. McL.

## ERRATUM.

Abstract No. 1026. The maximum fluid pressure of the slush-pump referred to should read 2000 lb/sq. in.

# BOOKS RECEIVED.

**Gas Turbines and Jet Propulsion for Aircraft.** G. Geoffrey Smith. London: Flight, 1946. 4th Edn. Pp. 246. 12*s.* 6*d.*

First published in 1942, the fourth edition has been brought up-to-date by the inclusion of additional matter and comment on various phases of modern gas turbine practice.

**Heat Engine Calculations.** A. E. Talbot. London: Sir Isaac Pitman & Sons Ltd., 1945. Pp. 89 + vi. 3*s.* 6*d.*

Based on the author's experience in teaching the principles involved and the calculations necessary for those engaged in the running and maintenance of diesel, petrol, steam and marine engines, this book should be particularly helpful to students.

**Our Oil Resources.** Edited by Leonard M. Fanning. New York: McGraw-Hill Book Co., 1945. Pp. 331 + viii. $4.

Eighteen authorities and oil company executives have contributed to this symposium on the development of U.S. oil resources. Questions of conservation, technology, reserves, and capital employed are discussed.

**Petroleum Production. Vol. I. Mechanics of Production: Oil, Condensate, Natural Gas.** Park J. Jones. New York: Reinhold Publishing Corpn., 1946. Pp. 228 + vii. $4.50.

The purpose of this volume is to set out for consideration a system of mechanics of producing oil and condensate prior to the breakthrough of displacing fluids into producing wells.

**Physical Constants of Hydrocarbons. Vol. III. Mononuclear Aromatic Hydrocarbons.** Gustav Egloff. New York: Reinhard Publishing Corpn., 1946. Pp. 661 + xiii. $15.

This volume follows the style of the previous two volumes in the series and is a collation of all melting point, boiling point, density, and refractive index data available before May, 1944, for the mononuclear aromatic hydrocarbons found in the world's resources.

**The Wild Catters.** Samuel W. Tait, Jr. Princetown, New Jersey: University Press, 1945. Pp. 218 + xvi. $3.

An informal history of the pioneers of the oil industry, including an account of early drilling in Ontario, the story of Salt Creek and a chapter on life in the boom oil towns.

**O Neftenosnosti Kizelovskogo Raiona (Petroleum Occurrence in the Kisel District).** N. A. Gedroitz and P. A. Sofronitzkii. Moscow-Leningrad, 1941. Pp. 40. Price 75 kopeks.

Short summary of previous work; significance of the Kizel region from the petroleum standpoint; stratigraphy and general geology of the area; oil-shows and bitumen deposits; results of chemical and geological investigations.

**Geologicheskoe Stroenie i Neftenosnost' Poluostrova Manguishlak (The Geological Structure of and Petroleum Occurrence in the Manguishlak Peninsula).** S. N. Alekseichik. Moscow-Leningrad, 1941. Pp. 96. Price 2 rubles 50 kopeks.

Geomorphology; stratigraphy; tectonics; signs indicating petroleum; other useful minerals.

**Issledovaniya po Khimii Prirodnuikh Asfal'tov (Investigations on the Chemistry of Natural Asphalts).** V. A. Uspenskii and A. I. Goraskaya. Moscow-Leningrad, 1941. Pp. 72. Price 2 rubles 25 kopeks.

This publication is divided into two parts, the first deals with the experimental chemical examination of solid bitumens from the pre-Ural region, whilst the second is devoted to a discussion of the acidic components of solid bitumens.

**Fauna Tretichnuikh Otlozhenii Yugo-vostochnoi Chasti Sovetskogo Sakhalina (Fauna of the Tertiary Deposits of the South-eastern Part of Soviet Sakhalin).** A. A. Simonova. Moscow-Leningrad, 1941. Pp. 80 + 25 plates. Price 4 rubles.

Stratigraphy; palaeontology; description of fauna belonging to the Pelecypoda, Scaphopoda, Gastropoda. A brief English summary is appended.

**Verkhnii Paleozoi Bashkirskoi A.S.S.R. (The Upper Palaeozoic of the Bashkir Autonomous Soviet Socialist Republic).** D. L. Stepanov. Moscow-Leningrad, 1941. Pp. 100 + 2 plates. Price 3 rubles 50 kopeks.

Stratigraphy; main features of the geological history of Bashkiria in the upper palaeozoic; the formation of limestone massives of the Ishimbaev type; petroleum deposits in the upper palaeozoic strata of Bashkiria.

The above five publications are Nos. 15, 16, 17, 18 and 20 respectively in a new series issued by the Petroleum Geological-Investigational Institute.

**Geologicheskoe Stroenie Severo-zapadnoi Chasti Zapadno-sibirskoi Nizmennosti i ee Neftenosnost'. (The Geological Structure of the North-western Part of the Western Siberian Depression and Petroleum Occurrence therein).** V. G. Vasil'ev. Moscow-Leningrad, 1946. Pp. 152. Price 10 rubles.

Cartographic sources; history of explorations; geology of the region; petroleum deposits.

**Problema Neftenosnosti Donetskogo Basseina (The Problem of Petroleum Occurrence in the Donetz Basin).** V. V. Veber. Moscow-Leningrad, 1945. Pp. 88. Price 6 rubles.

The region in question is the northern border of the Don basin. Profile; tectonics; oil-shows; oil-bearing problems of the zone.

**Nauchnuie Osnovui Poiskov Nefti (The Scientific Principles of the Search for Petroleum).** K. P. Kalitzkii. Moscow-Leningrad, 1944. Pp. 244. Price 35 rubles.

Signs indicating large-scale oil deposits; oil migration; formation of oil deposits; the origin of petroleum; determination of oil-bearing geological structures.

All the publications described above are published by the State publishing organization dealing with literature on petroleum and mined fuels.

V. B.

# ABSTRACTS AUTHOR INDEX.

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# INSTITUTE NOTES.

JANUARY, 1946.

## CADMAN MEMORIAL LECTURE.

The Institute has been appointed Trustee of a Fund comprised of contributions received from those associated with the Anglo-Iranian Oil Company, Ltd.

The object of the Fund will be to commemorate the work of the late Lord Cadman relating to Petroleum, and the Institute will arrange for a lecture to be delivered so far as is practicable every year, but in no case less than once in every three years.

The First Cadman Memorial Lecture will be delivered by Sir William Fraser, C.B.E., at the Royal Institution, Albemarle Street, London, W.1, on Wednesday, March 27, 1946.

Admission will be by ticket only. Further details in regard to the Lecture will be announced later.

---

## FORTHCOMING MEETINGS.

Wednesday, February 13, 1946. **Presidential Address,** by Professor F. H. Garner, O.B.E.

Wednesday, March 13, 1946. **"The Development of Fluid Catalytic Cracking,"** by Dr. J. F. Walter.

The above meetings will be held at 26 Portland Place, London, W.1., at 5.30 p.m.

---

## STANLOW BRANCH.

Wednesday, February 20, 1946. **"Lubricating Oil Additives,"** by Dr. A. J. Ham.

Wednesday, March 20, 1946. **"Engine Testing of Lubricating Oils,"** by C. D. Brewer.

Wednesday, April 17, 1946. **"Design, Erection and Operation of Pilot Plants,"** by C. Buck, T. Hayes, and R. C. Williams.

The above meetings will be held at the Grosvenor Hotel, Lower Mersey Street, Ellesmere Port, at 7.30 p.m.

---

## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Membership.*

BLACK, Robert John, Manager, Oil Dept., Jardine Skinner & Co., Calcutta. (*H. W. Chetwin ; S. H. Bean.*)

DUCKWORTH, Donald Matthew, Chemist, Ministry of Supply. (*D. Clayton ; E. R. Redgrove.*)

GOLDIE, Alexander, Chief Engineer, Sarawak Oilfields Ltd. (*H. de Wilde ; R. B. Wrixon.*)

HANSON, Thomas Kenneth, Research Chemist, Trinidad Leaseholds Ltd. (*W. B. Heaton ; S. M. Blair.*)

JAPES, Dudley Herbert, Laboratory Manager, " Shell " Refining & Marketing Co., Ltd., Stanlow. (*R. I. Lewis ; J. S. Jackson.*)

KNIGHT, Robert Harold, Trainee, Shell Refining & Marketing Co., Ltd. (*G. D. Thacker ; Peter Kerr.*)

MCGECHAN, Andrew Campbell, Mechanical Engineer, Anglo-American Oil Co., Ltd. (*E. Evans-Jones ; J. E. Jenkin.*)

RAINE, George Thomas, Assistant Chemist, Anglo-Iranian Oil Co., Ltd. (*Eric Dodds ; W. H. Thomas.*)

SLINGER, Francis Charles Peter, Geologist, Anglo-Iranian Oil Co., Ltd. (*G. M. Lees ; C. A. P. Southwell.*)

### *Transfers.*

DEWDNEY, Duncan Alexander Cox, Technical Adviser, Anglo-American Oil Co., Ltd. (*F. H. Garner ; H. C. Tett.*) (*Associate Member to Fellow.*)

ROY, Clarke, Sales Technician, Wm. Butler & Co. (Bristol) Ltd. (*E. R. Redgrove ; J. E. James.*) (*Associate Member to Member.*)

SASSON, Albert, Exploitation Engineer, United British Oilfields of Trinidad. (*G. D. Hobson ; S. E. Coomber.*) (*Student to Associate Member.*)

SEFTON, Ronald, Chief Analytical Chemist, Trinidad Leaseholds, Ltd. (*S. M. Blair, W. B. Heaton.*) (*Associate Member to Fellow.*)

WRAY, Anthony Tom, Assistant Chemist, Anglo-Iranian Oil Co., Ltd., Abadan. (*Student to Associate Member.*)

## WORLD POWER CONFERENCE.

A meeting of the International Executive Council of the World Power Conference was held in London in November, 1945. About twenty countries were represented at the meeting, which was under the Chairmanship of Sir Harold Hartley.

It was decided to hold, if possible, a Sectional Meeting in 1947 to discuss the general question of fuel economy, and also to resume publication of the Statistical Year Book as soon as possible.

A small committee is to be appointed to watch developments and to make recommendations to the International Executive Council as soon as it is practicable to have an effective discussion of the utilization of atomic energy for peacetime purposes.

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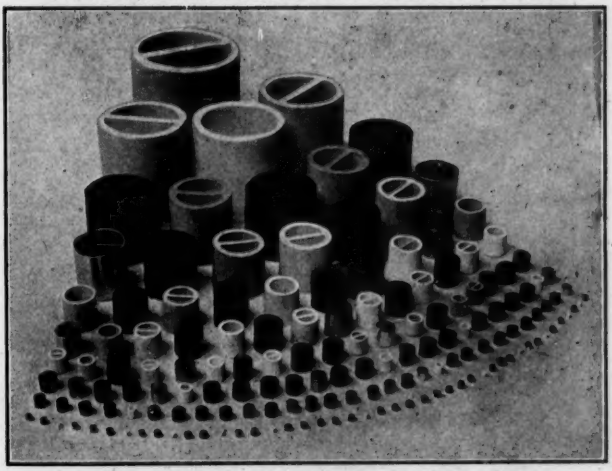

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FEBRUARY, 1946.

## CADMAN MEMORIAL LECTURE.

The Institute has been appointed Trustee of a Fund comprised of contributions received from those associated with the Anglo-Iranian Oil Company, Ltd.

The object of the Fund will be to commemorate the work of the late Lord Cadman relating to Petroleum, and the Institute will arrange for a lecture to be delivered so far as is practicable every year, but in no case less than once in every three years.

The First Cadman Memorial Lecture will be delivered by Sir William Fraser, C.B.E., at the Royal Institution, Albemarle Street, London, W.1, on Wednesday, 27th March, 1946, at 5.30 p.m.

Admission will be by ticket only, obtainable from the Secretary of the Institute of Petroleum.

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## FORTHCOMING MEETINGS.

Wednesday, 13th March, 1946. **"The Development of Fluid Catalytic Cracking,"** by Dr. J. F. Walter.

The meeting will be held at 26 Portland Place, London, W.1., at 5.30 p.m.

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## STANLOW BRANCH.

Wednesday, 20th March, 1946. **"Engine Testing of Lubricating Oils,"** by C. D. Brewer.

Wednesday, 17th April, 1946. **"Design, Erection and Operation of Pilot Plants,"** by C. Buck, T. Hayes, and R. C. Williams.

The above meetings will be held at the Grosvenor Hotel, Lower Mersey Street, Ellesmere Port, at 7.30 p.m.

## ELECTION OF OFFICERS.

The following have been elected Vice-Presidents of the Institute for the Session 1946–1947 :—

G. H. Coxon.
E. A. Evans.
A. C. Hartley, C.B.E.
V. C. Illing, M.A., F.R.S.
J. S. Jackson, B.Sc., F.R.I.C.
J. A. Oriel, M.C., M.A.

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## ELECTION FOR COUNCIL.

In accordance with the Articles of the Institute, the following members of Council retire at the next Annual General Meeting, but are eligible for re-election :—

E. B. Evans, Ph.D., M.Sc.
C. A. P. Southwell, M.C., B.Sc.
H. C. Tett, B.Sc., D.I.C.
A. Beeby Thompson, O.B.E.
A. Wade, D.Sc.
C. W. Wood, F.R.I.C.

New nominations have also been received in favour of :—

V. Biske, B.Sc., F.R.I.C.
C. Chilvers, B.Sc., F.R.I.C.
H. de Wilde, M.Sc., M.I.Mech.E.
F. L. Garton, M.A., B.Sc.
E. Evans-Jones, B.Sc., M.I.Mech.E., A.M.I.Mech.E.
E. LeQ. Herbert, B.Sc., F.R.I.C.
J. E. Southcombe, M.Sc.

As there are only seven vacancies on Council, it will be necessary to hold a Ballot in accordance with the By-Laws. Ballot papers will be circulated in the near future.

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## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

*Membership.*

Ablewhite, Kenneth, Asst. Exploitation Geologist, Trinidad Leaseholds, Ltd. (*H. H. Suter ; K. W. Barr*).

Andrew, William, Field Superintendent, Trinidad Leaseholds, Ltd. (*F. H. L. Tindall ; H. H. Suter*).

BOTTOM, James, Engineer, "Shell" Refining & Marketing Co., Ltd. (*J. A. Oriel ; E. LeQ. Herbert*).

Le CLAIR, Camille Clare Sprankling, Technical Director, Tecalemit Ltd. (*S. J. M. Auld ; A. C. Hartley*).

COSTELLOE, Hubert Creagh, Production Engineer, Apex (Trinidad) Oilfields, Ltd. (*J. D. Fullerton ; A. H. Richard*).

CURLET, Alexander Shearer, Chemist, Trinidad Leaseholds, Ltd. (*R. O. Young ; H. C. H. Darley*).

FARAG, Wahib, Chemist, Anglo-Egyptian Oilfields Ltd. (*H. E. F. Pracy ; J. L. Black*).

GRIMSHAW, Albert, Asst. Chemist, Anglo-American Oil Co., Ltd. (*F. Tipler ; G. M. Davies*).

HALEY, Arthur Harrison, Research Chemist, Trinidad Leaseholds, Ltd. (*H. C. H. Darley ; H. H. Suter*).

HAQ, A. H. M. Qamrul, Chemist, Attock Oil Co., Ltd.

JASZUNSKI, Szymon, Process Operating Foreman, Consolidated Oilfields, Ltd. (*R. C. H. Cox ; S. G. Tidy*).

JENKINS, Norman Marsden, Storage & Export Operator, Anglo-Iranian Oil Co., Ltd., Abadan.

MORRIS, William Stephen, Electrical Engineer, "Shell" Refining & Marketing Co., Ltd. (*J. A. Oriel ; E. LeQ. Herbert*).

MORRISON, Joseph Allison, Chief Materials Engineer, "Shell" Refining & Marketing Co., Ltd. (*J. A. Oriel ; E. LeQ. Herbert*).

NIVEN, Frederick William Archer, Draughtsman, "Shell" Refining & Marketing Co., Ltd. (*W. H. Park ; Peter Kerr*).

STEET, William Robert, Chemist, W. B. Dick & Co., Ltd. (*P. W. L. Gossling ; L. F. Moore*).

SUGAR, Henry, Chemist, R.A.O.C., Bombay. (*J. L. McKee ; G. Peace*).

SULIMIRSKI, Stefan, Engineer, Industrial Department, Polish Army. (*W. J. Klimkiewicz ; W. J. Piotrowski*).

TOGNI, Philip Ivor, Student, Royal School of Mines. (*V. C. Illing*).

WARDEN, Thomas Wilkie Muir, Technical Assistant, Central Mining & Investment Corpn. (*V. C. Illing ; H. C. W. Johnston*).

WATERS, John Farrell, Technical Assistant, Anglo-Iranian Oil Co., Ltd. (*D. Comins ; C. A. P. Southwell*).

WETHERELL, Kenneth, Trainee Exploitation Engineer, United British Oilfields of Trinidad, Ltd. (*G. F. Hazzard ; J. E. Smith*).

WILDE, Marcel Frederick, Chemist & Director, Oiline Refining Co. Ltd. (*P. H. Snow ; Wm. Blackwell*).

WILKIE, Sydney Kerr, Asst. Petroleum Technologist, Apex (Trinidad) Oilfields Ltd. (*A. H. Richard ; H. W. Reid*).

*Transfers.*

BALDWIN, Alan Henry, Army Officer, R.E.M.E. (*T. G. Hunter ; A. H. Nissan*). (*Student to Associate Member*).

De BRUIJN, Jan Antonie, Chief Chemist, Dutch Chinol Ltd. (*H. I. Waterman*). (*Student to Associate Member*).

CAHILL, Patrick, Analytical Chemist, W. J. Bush & Co., Ltd. (*E. P. Driscoll ; A. R. Stark*). (*Student to Associate Member*).

EVERIST, Geoffrey Edward, Chemist, Shell-Mex and B.P. Ltd. (*A. E. Hope ; H. E. Priston*). (*Associate Member to Member*).

FREWING, Joseph John, Chemist, "Shell" Central Laboratories. (*R. I. Lewis ; J. S. Jackson*). (*Student to Member*).

HICKS, Alexander Edward, Assistant Chemist, Anglo-Iranian Oil Co., Ltd. (*D. A. Howes ; W. A. Partridge*). (*Student to Associate Member*).

WOOD, George Frederick, Research Worker, Birmingham University. (*F. H. Garner ; A. H. Nissan*). (*Student to Associate Member*).

## HONOURS.

Included in the New Year Honours are the following :—

KNIGHTS BACHELOR.

H. B. Heath Eves (Fellow). Lt.-Col. R. A. Thomas, C.B.E. (Hon. Member).

C.B.E.

Air Commodore R. A. Chisholm, D.S.O., D.F.C. (Associate Member).

O.B.E.

L. W. Berry (Associate Member). C. S. Cleverley (Associate Member).
J. E. Jenkin (Fellow).

M.B.E.

J. R. G. Barter (Fellow).

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## INSTITUTE APPOINTMENTS.

Mr. Peter Kerr, M.A., B.Sc., F.Inst.Pet., has been appointed Technical Secretary, and Mr. George Sell, F.Inst.Pet., Publications Secretary. Both will commence their new duties on the 1st March, 1946.

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## LIST OF MEMBERS.

A list of members is now being prepared for early publication and members desiring to make changes are requested to notify the Secretary immediately.

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## INCORRECT ADDRESSES.

The Secretary would welcome any information regarding the present addresses of any of the members listed below :—

William Allan.
Darrel G. F. Bailey.
D. E. Bookless.
N. M. Brodie.
E. C. Brown.
J. Chapman Brown.
K. Burton.
E. B. Chapelle.
P. B. Clayton.
C. S. Cleverly.
F. A. J. Cole.
R. F. Connock.
S. Crossley.
J. C. Daniel.
A. K. Davis.
R. F. Douglas.
R. Dunn.
C. H. Edmonds.
M. M. Faingar.
R. R. Ferner.
David Filitz.
A. Frame.
A. W. Furniss.
P. A. Garrett.
V. C. S. Georgescu.
H. Gibson.
A. J. Goodman.
H. A. S. Gothard.
Wm. Hawkins.
Richard S. H. Hebbard.
G. E. Heisch.
H. K. Hekmat.
W. Helmore.
G. O. Higgins.
F. J. Hudson.
L. J. Huggins.
A. G. Hutchison.
R. A. Ijdens.
L. J. Jeffreys.
W. P. Jones.

W. J. Kemnitzer.
J. Khalili.
F. G. Lauchner.
A. P. Lieser.
F. W. Longbottom.
I. Lusty.
J. F. F. McQueen.
Edward T. Marshall.
T. F. Mason.
R. P. Matthews.
Mrs. B. E. Mielnikowa.
T. A. Miller.
S. Moazami.
B. Mostofi.
V. Nercessian.
W. W. Neville.
Stewart Nicol.
G. A. O'Neill.
Simon Papp.
E. Poppy.
C. W. M. Read.
L. G. M. Roberts.
A. W. Robinson.
T. W. S. Robinson.
D. A. Shackell.
D. L. Ramsay Smith.
H. G. Spearpoint.
J. Tavana.
H. E. Tester.
Percy F. Thurlow.
P. Tonge.
Bernard J. Vavasour.
H. C. G. Vincent.
J. T. Ward.
F. C. Waters.
J. G. Whitney.
Ing. A. S. Wolfner.
Norman E. Wood.
P. W. Wright.


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# INSTITUTE NOTES.

MARCH 1946.

## FORTHCOMING MEETINGS.

Tuesday, April 9, 1946. At the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 2, by invitation of the I.E.E., when the following papers will be read, followed by a general discussion :—

**"The Sludge Test for Transformer Oils,"** by C. H. Barton.

**"A Review of the Mechanism of the Oxidation of Liquid Hydrocarbons,"** by P. George and A. Robertson (Cambridge University).

**"The Influence of Structure on the Oxidation Reactivity of Hydrocarbons,"** by P. George and A. Robertson.

**"Some Developments in the Refining of Transformer Oil,"** by J. C. Wood-Mallock.

**"Survey of B.E.I.R.A. Work on Transformer Oil,"** by P. W. L. Gossling and A. C. Michie.

**"Effect of Water Temperature on the Sludge Test,"** by P. W. L. Gossling and J. Romney.

**"Oxidation Tests for Transformer Oil,"** by A. A. Pollitt.

**"Oxidation and Anti-Oxidation,"** by E. A. Evans.

Wednesday, May 8, 1946. At Manson House, 26, Portland Place, W.1.

**"The Geology of the Guayaquil Estuary, Ecuador,"** by Dr. G. Sheppard.

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## STANLOW BRANCH.

Wednesday, April 17, 1946. At the Grosvenor Hotel, Lower Mersey Street, Ellesmere Port, at 7.30 p.m.

**"Design, Erection and Operation of Pilot Plants,"** by C. Buck, T. Hayes and R. C. Williams.

---

## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

CHURCHFIELD, Stanley Edward, Student, Royal School of Mines. (*V. C. Illing.*)

DALLOW, Frank, Asst. Lubricants Manager, Redline-Glico Ltd. (*G. M. Davies; C. E. Burnett.*)

EVANS, William Johnston, Superintendent, Petroleum Board. (*D. Stanley Hill; H. G. L. Wilkinson.*)

JENKINS, Edgar Harold, Engineering Officer, Royal Air Force. (*W. Johnson; J. Mason.*)

JONES, Norman Ellathorne, Chemist, "Shell" Refining & Marketing Co., Ltd. (*P. M. Griffiths; E. LeQ. Herbert.*)

LEE, George Herbert, Engineer, Anglo-American Oil Co., Ltd. (*W. E. J. Broom; K. T. Arter.*)

MURRAY, Morrice Arthur Kemmis, Engineer. (*E. C. Scott; H. C. W. Johnston.*)

NEWTON, Henry, Draughtsman, Anglo-Iranian Oil Co., Ltd., Abadan.

SPENCE, Huntly Gordon, Lubrication Engineer, Berry Wiggins & Co., Ltd. (*N. L. Anfilogoff; David Eve.*)

SPENS, Patrick Archibald, Assistant Geologist, British Controlled Oilfields. (*V. C. Illing; G. D. Hobson.*)

STROUD, Alexander Lionel, Manufacturers' Representative.

THISTLETON, Paul, Research Physicist, Esso European Laboratories. (*W. E. J. Broom; K. T. Arter.*)

TOOMER, David Arthur, Draughtsman, Agwi Petroleum Corporation, Ltd. (*K. Parsonage; G. Noble.*)

WILDE, Marcel Frederick, Chemist and Director, Oiline Refining Co., Ltd. (*P. H. Snow; W. Blackwell.*)

WILLIAMS, Kenneth Alan, Consultant Chemist. (*C. S. Windebank; R. S. Teale.*)

WRIGHT, Ernest Peter, Research Student, University of Birmingham. (*F. H. Garner; A. H. Nissan.*)

### *Applications for Transfer.*

BOWEN, Clifford Ormond, Flying Officer, R.C.A.F. (*E. A. Evans; J. C. Cragg*). (*Associate Member to Member.*)

MARTIN, Cyril William Grierson, Fuel Technologist, "Shell" Petroleum Co., Ltd. (*R. I. Lewis; J. S. Jackson*). (*Member to Fellow.*)

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## PERSONAL NOTES.

MR. A. HEDLEY WILLIAMS has been released from his appointment as Regional Controller, Ministry of Supply, after holding the post from September, 1939, to date.

## LIST OF MEMBERS.

A list of members is now being prepared for early publication and members desiring to make changes are requested to notify the Secretary immediately.

---

## INCORRECT ADDRESSES.

The Secretary would welcome any information regarding the present addresses of any of the members listed below :—

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J. Chapman Brown.
K. Burton.
E. B. Chapelle.
P. B. Clayton.
F. A. J. Cole.
R. F. Connock.
S. Crossley.
J. C. Daniel.
A. K. Davis.
R. F. Douglas.
R. Dunn.
C. H. Edmonds.
M. M. Faingar.
R. R. Ferner.
David Filitz.
A. Frame.
G. W. Furniss.
P. A. Garrett.
V. C. S. Georgescu.
H. Gibson.
A. J. Goodman.
H. A. S. Gothard.
Wm. Hawkins.
Richard S. H. Hebbard.
G. E. Heisch.
H. K. Hekmat.
W. Helmore.
G. O. Higgins.
F. J. Hudson.
L. J. Huggins.
A. G. Hutchison.
R. A. Ijdens.
L. J. Jeffreys.
W. P. Jones.
W. J. Kemnitzer.
J. Khalili.
F. G. Lauchner.
A. P. Lieser.
F. W. Longbottom.
I. Lusty.
J. F. F. McQueen.
Edward T. Marshall.
T. F. Mason.
R. P. Matthews.
Mrs. B. E. Mielnikowa.
T. A. Miller.
S. Moazami.
B. Mostofi.
V. Nercessian.
W. W. Neville.
G. A. O'Neill.
Simon Papp.
E. Poppy.
C. W. M. Read.
L. G. M. Roberts.
A. W. Robinson.
T. W. S. Robinson.
D. L. Ramsay Smith.
H. G. Spearpoint.
J. Tavana.
H. E. Tester.
Percy F. Thurlow.
P. Tonge.
Bernard J. Vavasour.
H. C. G. Vincent.
J. T. Ward.
J. G. Whitney.
Norman E. Wood.

---

## BALLOT FOR COUNCIL.

Ballot papers were circulated to 1105 members of the Institute having registered addresses in the United Kingdom and 400 were returned. As the result of the Ballot the following were elected to fill the seven vacancies on the Council for 1946–1947 :—

C. Chilvers, B.Sc., F.R.I.C.
E. B. Evans, Ph.D., M.Sc., F.R.I.C.
F. L. Garton, M.A., B.Sc.
C. A. P. Southwell, M.C., B.Sc.
H. C. Tett, B.Sc., D.I.C.
A. Beeby Thompson, O.B.E.
C. W. Wood, F.R.I.C.

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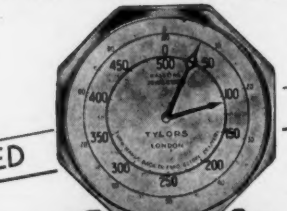


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# INSTITUTE NOTES.

APRIL, 1946.

## FORTHCOMING MEETINGS.

Wednesday, May 8, 1946, at Manson House, 26 Portland Place, London, W. 1. :—**"The Geology of the Guayaquil Estuary, Ecuador,"** by Dr. G. Sheppard.

Wednesday, June 12, 1946, at Manson House, 26 Portland Place, London, W.1 :—**"The Application of Variance Analysis to Some Problems of Petroleum Technology,"** by H. M. Davies, Ph.D., A.R.I.C.

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## DR. A. E. DUNSTAN.

At the end of last year Dr. A. E. Dunstan, who for the past twenty-five years has been the Institute's Honorary Editor, signified his desire to resign from that position. His resignation was accepted with much regret by the Council.

It was in 1920 when Dr. Dunstan first became closely associated with the *Journal* as Honorary Associate Editor and in the following year he succeeded the late W. H. Dalton as Honorary Editor. Under his wise guidance the *Journal* and other publications of the Institute have gained a high reputation in the literature of the petroleum industry and the high standard set by him in the earlier years has been maintained in spite of the vicissitudes of war.

As some indication of the progress of the *Journal* under Dr. Dunstan's supervision it may be mentioned that for the year 1921 it was published in five parts only with a total of 471 pages. Ten years later, in 1931, it had become a regular monthly publication and contained 1330 pages, including 570 pages of abstracts of current literature. Last year (1945), even though restricted by paper shortage, there were 494 pages of original papers and 414 pages of abstracts.

An important feature of the *Journal* which owes its inception to Dr. Dunstan is the Abstract Section, which he started in 1921. Similarly, the Annual Reviews of Petroleum Technology were initiated by him in 1924 as part of the *Journal*, and a few years later became a separate publication, only being suspended after 1940 on account of war conditions. The gap is to be filled this year by a volume covering progress in the intervening years.

Apart from the *Journal*, Dr. Dunstan has also been editorially responsible for all publications of the Institute, including *Proceedings of the First World Petroleum Congress*, *Petroleum—25 Years Retrospect*, *Oil-Shale and Cannel Coal*, *Dangerous Gases in the Petroleum Industry* and *Standard Methods for Testing Petroleum and Its Products*. These publications in themselves will act as a record for all time of the outstanding part which Dr. Dunstan has played in the affairs of the Institute.

In succession to Dr. Dunstan the Council have appointed Prof. F. H. Garner, O.B.E., as Honorary Editor. He has been Honorary Associate Editor since 1936.

---

## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

AULT, William Sinclair, Assistant Refinery Manager, "Shell" Refining & Marketing Co., Ltd. (*E. LeQ. Herbert ; H. E. F. Pracy.*)

BEDFORD, Douglas Ernest, Manager's Assistant, Stocks & Terminals Dept., Petroleum Board. (*F. H. Garner ; A. Osborn.*)

COURTNEY, James, Chief Executive (Engineering), Northern Ireland Road Transport Board. (*R. R. Dunn ; H. E. Brown.*)

DONALDSON, James, Assistant Operator, Anglo-Iranian Oil Co., Ltd., Abadan.

ELLIS, Eric George, Chemist, Vacuum Oil Co., Ltd. (*S. J. M. Auld ; E. R. Blane.*)

KING-FARLOW, Denys, Trade Relations Dept., Shell Petroleum Co., Ltd. (*C. L. Gilbert ; H. Hyams.*)

FLEMING, Howard William, Chemist, "Shell" Refining & Marketing Co., Ltd. (*H. E. F. Pracy ; J. L. Black.*)

FRASER, John Alexander, Student, Glasgow University. (*W. M. Cumming.*)

GIBSON, David Stuart, Assistant Mechanical Engineer, Trinidad Petroleum Development Co., Ltd. (*R. R. Tweed ; F. G. Rappoport.*)

HUTT, Eric Tom, Senior Research Engineer, Shell Lubricating Oil Laboratory. (*C. H. Johnson ; J. Cantor.*)

IRVINE, Douglas, Laboratory Assistant, Anglo-American Oil Co., Ltd. (*C. Chilvers ; T. C. G. Thorpe.*)

MEADOWS, Henry Thompson, Technical Representative, Silvertown Lubricants, Ltd. (*L. O. Maskell ; A. F. Goodwin.*)

MONTGOMERY, Edmund Charles, Electrical Oils Technologist, Silvertown Lubricants, Ltd. (*L. O. Maskell ; A. F. Goodwin.*)

NEPPE, Max Leonard, Chemist, South African Torbanite Mining & Refining Co., Ltd. (*W. T. Jarrett ; E. C. Schiffman.*)

O'CONNOR, Michael Anthony, General Manager & Director, Shamrock Petrol Ltd. (*R. R. Dunn ; J. S. Parker.*)

OGILVIE, Ronald, Production Engineer, Anglo-Ecuadorian Oilfields, Ltd. (*W. W. Connor ; C. Barrington Brown.*)

REGAN, Joseph William, Consulting Lubricating Engineer, Caltex (Africa) Ltd. (*W. H. Scharges ; J. W. Weitz.*)

RIGDEN, David Thomas, Assistant Chemist, Anglo-Iranian Oil Co., Ltd. (*W. A. Partridge ; F. J. Patman.*)

THOMPSON, Oliver Frederic, Administrative Position, Shell Petroleum Co., Ltd. (*J. A. Oriel ; E. LeQ. Herbert.*)

TREMAINE, John Frederick, Senior Analytical Chemist, Esso European Laboratories. (*W. E. J. Broom ; A. Osborn.*)

WARDILL, Thomas Edwin Mandall, Medical & Welfare Officer, Trinidad Petroleum Development Co., Ltd., Trinidad. (*C. C. Wilson ; A. H. Richard.*)

### *Applications for Transfers.*

BASKIN, Leon, Petroleum Technologist, Haifa. (*Student to Associate Member.*)

BLACK, John Linton, Refinery Manager, "Shell" Refining & Marketing Co., Ltd. (*H. E. F. Pracy ; J. G. Hancock.*) (*Associate Member to Member.*)

DOWN, Arthur Lewis, Chemical Engineer, Trinidad Leaseholds, Ltd. (*A. R. Richards ; A. G. V. Berry.*) (*Student to Member.*)

MCEWEN, George Charles, Technical Civil Servant, Ministry of Aircraft Production. (*J. Mason ; S. R. Hills.*) (*Associate Member to Member.*)

MCGRATH, Leonard, Chemist, Lobitos Oilfields, Ltd. (*V. Biske ; J. C. Wood-Mallock.*) (*Student to Associate Member.*)

MARTIN, Rex Ingram, Geologist, Trinidad Leaseholds, Ltd. (*K. W. Barr ; H. H. Suter.*) (*Student to Member.*)

MOORE, Philip Harold, Petroleum Technologist, Moore & Barrett. (*J. Barrett ; Harold Moore.*) (*Member to Fellow.*)

ROWNTREE, Walter Beveridge, Chemical Dept., Petroleum Board. (*F. N. Harrap ; T. C. R. Baker.*) (*Associate Member to Member.*)

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# INSTITUTE NOTES.

MAY, 1946.

## FORTHCOMING MEETINGS.

Wednesday, June 12, 1946, at Manson House, 26 Portland Place, London, W.1 :—**"The Application of Variance Analysis to Some Problems of Petroleum Technology,"** by H. M. Davies, Ph.D., A.R.I.C.

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## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

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### *Applications for Membership.*

BOON, Cyril Bertrand, Works Chemist/Supervisor, Germ Lubricants Ltd. (*J. E. Southcombe ; J. S. Parker.*)

COURTAN, Maurice Marcel, Engineer-in-Chief, S. A. des Petroles Jupiter, Paris.

FIRMINGER, John, Laboratory Chemist, Esso European Laboratories. (*C. S. Windebank ; A. Osborn.*)

FOTHERGILL, Hugh Cyril Stanislaus, Regional Manager, Petroleum Board. (*F. H. Garner ; H. C. Tett.*)

JENNISON, John Anthony, Chemist, Manchester Oil Refinery Ltd. (*E. J. Dunstan ; G. H. Harries.*)

LANGSTON, Robert Pembruge, Chemist, Burt, Boulton & Haywood Ltd. (*T. Kennedy ; C. E. J. Langdon.*)

MEAD, Brian, Refining Representative, Standard Oil Co. (New Jersey). (*H. C. Tett ; F. H. Garner.*)

PAUL, Peter Ferguson MacLachlan, Chemist, J. O. Buchanan & Co. Ltd.

SMITH, Clement Greville, Deputy Chief Chemist, Limmer & Trinidad Lake Asphalt Co. Ltd. (*A. W. Attwooll ; D. C. Broome.*)

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## *Applications for Transfer.*

BOWKER, Thomas Dennis, Assistant Works Manager, London Oil Refining Co. Ltd. (*J. E. Haslam ; H. S. Kiernan.*) (*Student to Associate Member.*)

DENNIS, Cyril Frederick, Director, British Oilfield Equipment Co. Ltd. (*N. Matheson ; C. R. Sams.*) (*Member to Fellow.*)

PARR, Ronald Walter, Chemist, "Shell" Central Laboratories. (*W. R. P. Hodgson ; P. G. Higgs.*) (*Student to Associate Member.*)

PERKS, John Gilbert, Captain, R.E.M.E. (*T. G. Hunter ; A. H. Nissan.*) (*Student to Associate Member.*)

THORPE, Thomas Charles Gordon, Sectional Head, Chemical Laboratories, Anglo-American Oil Co. Ltd. and Petroleum Board. (*C. Chilvers ; E. B. Evans.*) (*Associate Member to Fellow.*)

# INSTITUTE NOTES.

JUNE, 1946.

## COUNCIL COMMITTEES.

### 1946–1947.

The President, Chairman of Council, and the Joint Honorary Secretaries are ex-officio members of all Committees.

* Denotes members of Council.

**Awards Committee.**

*E. A. EVANS (*Chairman*).
*S. J. M. AULD.
*A. E. DUNSTAN.
*A. C. HARTLEY.
*F. B. THOLE.

**Benevolent Fund Committee.**

*A. E. DUNSTAN (*Chairman*).
*S. J. M. AULD.
*J. A. ORIEL.

**Branches Committee.**

*J. A. ORIEL (*Chairman*).
*R. I. LEWIS.
*E. THORNTON.
*W. J. WILSON.

*Northern Branch :*

*G. H. THORNLEY, *Branch Chairman.*
V. M. FARRANT, *Branch Hon. Sec.*

*Scottish Branch :*

*R. CRICHTON, *Branch Chairman.*
W. R. GUY, *Branch Hon. Sec.*

*S. Wales Branch :*

R. B. SOUTHALL, *Branch Chairman.*
E. J. HORLEY, *Branch Hon. Sec.*

*Stanlow Branch :*

H. E. F. PRACY, *Branch Chairman.*
J. G. HANCOCK, *Branch Hon. Sec.*

Also representatives of Overseas Branches when available.

**By-Laws Committee.**

*H. HYAMS (*Chairman*).
*S. J. M. AULD.
*G. H. COXON.
*T. DEWHURST.
*J. KEWLEY.
*F. B. THOLE.
*E. THORNTON.
*C. W. WOOD.

**Education Committee.**

*E. THORNTON (*Chairman*).
*S. J. M. AULD.
*A. E. DUNSTAN.
*E. B. EVANS.
PERCY EVANS.
*F. H. GARNER.
*V. C. ILLING.
*J. S. JACKSON.
*J. S. PARKER.
G. D. THACKER.

**Election Committee.**

*M. A. L. BANKS (*Chairman*).
*J. S. JACKSON.
*R. I. LEWIS.
*E. R. REDGROVE.
*C. W. WOOD.

### Engineering Committee.

*A. C. HARTLEY (*Chairman*).

The Chairmen of the following Panels :

Exploitation.
Drilling.
Production.
Electrical.
Storage.
Transportation.
Refining.

and other members to be nominated.

### Finance Committee.

*G. H. COXON (*Chairman*).
*J. A. ORIEL.
*E. R. REDGROVE.
*H. C. TETT.
*R. R. TWEED.
*W. J. WILSON.
*C. W. WOOD.

### House Committee.

*C. A. P. SOUTHWELL (*Chairman*).
*S. J. M. AULD.
E. LEQ. HERBERT.
*SIR THOMAS HOLLAND.

### Publication Committee.

*F. H. GARNER (*Chairman*).
J. R. G. BARTER.
W. H. CADMAN.
*A. E. DUNSTAN.
*E. A. EVANS.
*F. L. GARTON.
C. L. GILBERT.
E. W. HARDIMAN.
*H. HYAMS.
L. IVANOVSZKY.
*J. S. PARKER.
E. COOPER SCOTT.
*F. B. THOLE.
*A. BEEBY THOMPSON.
*G. H. THORNLEY.
*E. THORTON.
*C. W. WOOD.

*Correspondent Members :*

*Northern Branch*—

*Scottish Branch*—A. FLEMING.

*Stanlow Branch*—V. BISKE.

*South Wales Branch*—E. J. HORLEY.

The following report to the Publication Committee :

Abstracts Sub-Committee.
Library Sub-Committee.
Papers Sub-Committee.

### Research Committee.

*H. C. TETT (*Chairman*).
*S. J. M. AULD.
S. M. BLAIR.
*E. J. DUNSTAN.
*F. H. GARNER.
D. A. HOWES.
*J. S. JACKSON.
*R. I. LEWIS.
*J. A. ORIEL.
*E. R. REDGROVE.
C. S. WINDEBANK.

The Hydrocarbon Research Group reports to the Research Committee.

### Standardization Committee.

*J. S. JACKSON (*Chairman*).
*S. J. M. AULD.
W. E. J. BROOM.
*A. E. DUNSTAN.
*E. A. EVANS.
*E. B. EVANS.
*F. H. GARNER.
*F. L. GARTON.
D. A. HOWES.
*H. HYAMS.
A. OSBORN.
*J. S. PARKER.
*E. R. REDGROVE.
A. R. STARK.
*F. B. THOLE.
W. H. THOMAS.
*W. J. WILSON.
C. S. WINDEBANK.

*Co-opted Members :*

Lt.-Col. O. A. Bell (War Office).
J. M. Drinkwater (Ministry of Supply).
C. D. Lawrence (Admiralty).
R. J. W. LeFevre (R.A.E.).
J. Mason (Ministry of Supply).
T. R. Thomas (Ministry of Supply).

*Honorary Members :*

R. P. Anderson.
T. A. Boyd.
E. W. Dean.
T. G. Delbridge.
T. G. Detwiler.
F. D. Tuemmler.

The following report to Standardization Committee :—

Sub-Committee No. 1.—Measurement and Sampling.
No. 2.—Crude Oil.
No. 3.—Liquefied Petroleum Gases, Gasoline, Kerosine, and Light Distillates.
No. 4.—Gas, Diesel, and Fuel Oil.
No. 5.—Engine Tests.
No. 6.—Lubricants.
No. 7.—Asphaltic Bitumen.
No. 8.—Petroleum Wax.
No. 9.—Derived Chemicals.
No. 10.—Apparatus.
No. 11.—Nomenclature.
No. 12.—Greases.
Editorial Sub-Committee.

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## NORTHERN BRANCH.

Officers and Committee of the Northern Branch of the Institute for the 1946–47 Session are :

G. H. Thornley, *Chairman.*
E. J. Dunstan, *Vice-Chairman.*
V. M. Farrant, *Hon. Secretary.*
E. R. Wilson, *Hon. Treasurer.*

*Committee :*

H. H. Ballard.
C. E. Burnett.
A. J. Featherstone.
B. A. C. Gray.
J. E. Haslam.
Alick Ogden
T. W. Ranson
A. W. Woolridge.

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## SCOTTISH BRANCH.

The Scottish Branch of the Institute of Petroleum was re-inaugurated at a meeting in Glasgow on April 5, 1946, when Mr. Robert Crichton, Chairman of the Branch, presided. He recalled that the

Branch was first formed in 1938 and functioned with considerable success until the outbreak of the war. With so many members on war work or in the Forces and the difficulties of travel and black-out it had not been possible to hold meetings during the war. However, the committee had been kept in being and contact maintained with other learned societies. The Branch has now been re-inaugurated, he said, and a programme for the session commencing in October is in preparation.

Officers of the Branch for the 1946–47 Session are :

ROBERT CRICHTON, *Chairman.*
J. T. GUTHRIE, *Vice-Chairman.*
G. H. SMITH, *Hon. Treasurer.*
A. FLEMING, *Hon. Recorder.*
W. ROBERT GUY, *Hon. Secretary.*

*Committee :*

J. M. CALDWELL
Prof. W. M. CUMMING
H. MACARTHUR
} *Corporate members.*

W. REID
H. B. NISBET
H. PEDEN.
} *Non-corporate members.*

At the conclusion of the business meeting, Prof. F. H. Garner delivered his address on " Petroleum in War Time."

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## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

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The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

BADDILEY, John Raymond, Petroleum Engineer, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

BIDDOLPH, Charles William John, Commercial Manager, Pressure Lubricants Ltd. (*R. B. Hobson ; Harold Moore.*)

BROOKS, Roy, Chemist, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

BUTLER, Arthur Henry Stanley, Process Supervisor, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

DAY, Sidney, Refinery Cost Accountant, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

GOLLIN, Geoffrey Joseph, Chief Engineer, Fuel Oil Technical Dept., Shell Petroleum Co. Ltd. (*J. A. Oriel ; R. I. Lewis.*)

HALL, Peter Charles, Assistant Chemist, Ministry of Supply. (*H. A. Ruffell ; A. C. Pepper.*)

HOLMES, George William Dan, Works Chemist, Berry Wiggins & Co. Ltd. (*A. Evans : D. Eve.*)

JAGGER, Henry, Technical Assistant, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

LITHERLAND, Frederick Warren, Technical Representative, Silvertown Lubricants Ltd. (*L. O. Maskell ; J. A. Bennett.*)

MAXWELL, George Barton, Lieut.-Col., R.A.S.C., Petroleum Co-Ord. Authority, Germany. (*G. H. Coxon ; A. E. Dunstan.*)

MILLER, Wilfred George, Acting Assistant Chief Chemist, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

REES, Leslie Michael John, Works Chemist, Agwi Petroleum Corpn. Ltd. *H. D. Demoulins ; G. Noble.*)

SALOMON, Tobie G., Professor, School of Petroleum, Strasbourg University. (*A. E. Dunstan ; E. A. Evans.*)

STROUD, Herbert James, Designer Draughtsman, "Shell" Refining & Marketing Co. Ltd. (*E. LeQ. Herbert ; J. W. Vincent.*)

WALKER, Arthur, Technical Assistant, Agwi Petroleum Corpn. Ltd. (*H. D. Demoulins ; G. Noble.*)

WILLIAMS, Harold Derek, Examiner, Petroleum Section, A.I.D. Test House. (*J. Mason ; Harold Moore.*)

### *Applications for Transfer.*

BALFOUR, Nicholas Robert, Sales Engineer, Oil Well Supply Co. (*C. T. Longcroft ; Ashley Carter.*) (*Student to Member.*)

JAVES, Archie Ronald, Chemist, Anglo-Iranian Oil Co. Ltd. (*A. E. Dunstan ; D. A. Howes.*) (*Associate Member to Fellow.*)

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## NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, paras. 9 and 10.

*As Fellows.*

BELCHETZ, Leonard
BROWN, Ewart G.
HANSON, Thomas K.
HAYGARTH, Cecil H. S.
MARTIN, C. W. G.
THOMPSON, O. F.

*Transfers to Fellow.*

DEWDNEY, D. A. C.
NISSAN, Alfred H.

*As Members.*

ANDREW, W.
AULT, W. S.
BAGG, Douglas G.
BEVAN, Leslie.
BLACK, R. J.
BOTTOM, J.
CAMERON, Ian
COURTNEY, J.
DAINTITH, Harold
DALLOW, F.
DUCKWORTH, D. M.
ELLIS, E. G.
FARAG, Wahib
FLEMING, H. W.
GOLDIE, A.
HALEY, A. H.
JAPES, D. H.
JONES, N. E.
KING-FARLOW, D.
LE CLAIR, C. C. S.
LEE, G. H.
MCGECHAN, A. C.
MURRAY, M. A. K.
OGILVIE, R.
REGAN, J. W.
SLINGER, F. C. P.
SPENS, P. A.
SUGAR, H.
SULIMIRSKI, S.
WARDILL, T. E. M.
WATERS, J. F.
WILLIAMS, K. A.
VERSFELD, Ivan H.

*Transfers to Member.*

BLACK, J. L.
BOWEN, C. O.
DOWN, A. L.
EVERIST, G. E.
FREWING, J. J.
MCEWEN, G. C.
MARTIN, R. I.
POMEROY, Ralph G.
ROWNTREE, W. B.
ROY, Clarke
SEFTON, R.

*As Associate Members.*

ABLEWHITE, L.
BEDFORD, D. E.
BURGESS, Henry M.
COSKER, William L.
COSTELLOE, H. C.
COWDEN, Leslie H.
DONALDSON, J.
EVANS, W. J.
GIBSON, D. S.
GREGORY, S. A.
HAQ, A. H. M. Qamrul
HUTT, E. T.
JASZUNSKI, S.
JENKINS, E. H.
JENKINS, N. M.
MAKOWER, Arthur D.
MEADOWS, H. T.
MONTGOMERY, E. C.
MORRIS, W. S.
NEPPE, M. L.
NEWTON, H.
NIVEN, F. W. A.
O'CONNOR, M. A.
PAGE, George F.
RAINE, G. T.
RIGDEN, D. T.
SNOWDEN, Alfred G.
STREET, W. R.
STROUD, A. L.
SWANN, Raymond V.
TOOMER, D. A.
TREMAINE, J. F.
WARDEN, T. W. M.
WILDE, M. F.

*Transfers to Associate Member.*

CAHILL, P.
DE BRUIJN, J. A.
HICKS, A. E.
MCGRATH, L.
SASSON, A.
WOOD, G. F.
WRAY, A. T.

*As Students.*

BOTTOMLEY, G. Y.
CHURCHFIELD, S. E.
FALLAH, Abbas
FALLAH, Mohsen
FRASER, J. A.
FRITH, J. F. S.
HALL, P. G.
HOLDING, A. E.
HYNE, B. G.
IRVINE, D.
KNIGHT, R. H.
RAFIEE, Ali-Asghar
RHODES, F. H. T.
ROSE, E. C.
RYALLS, R.
SEPEHRI, Esfandiar
SKELLAND, A. H. P.
SOLHKHAH, Edward
STREET, B. F.
SPENCE, H. G.
SZWAJCER, M.
THISTLETON, P.
TOGNI, P.
WETHERELL, K.
WILKIE, S. K.
WRIGHT, E. P.

## PERSONAL NOTES.

HAROLD G. B. PERRY, who before the war was with the Standard Vacuum Oil Co. Ltd. in Shanghai and was a political prisoner during the war, writes us from 94, Canton Road, Shanghai.

THOMAS H. G. BRAYFIELD, who was released from the Stanley Internment Camp in September last, left Hongkong in March on vacation during which he hoped "to take in the Rainbow trout fishing on the lakes in the vicinity of Kamloops, British Columbia." He expects to be in England in August or September.

ARTHUR G.V. BERRY, superintendent of the Research and Development Department of Trinidad Leaseholds Ltd., expects to leave Trinidad late in June on vacation and to arrive in England early in July.

BRIAN ORCHARD LISLE, who served with the American Forces during the war and lately with the Oil Section of the Economics Division of the U.S. Office of Military Government of Germany, has now returned to New York.

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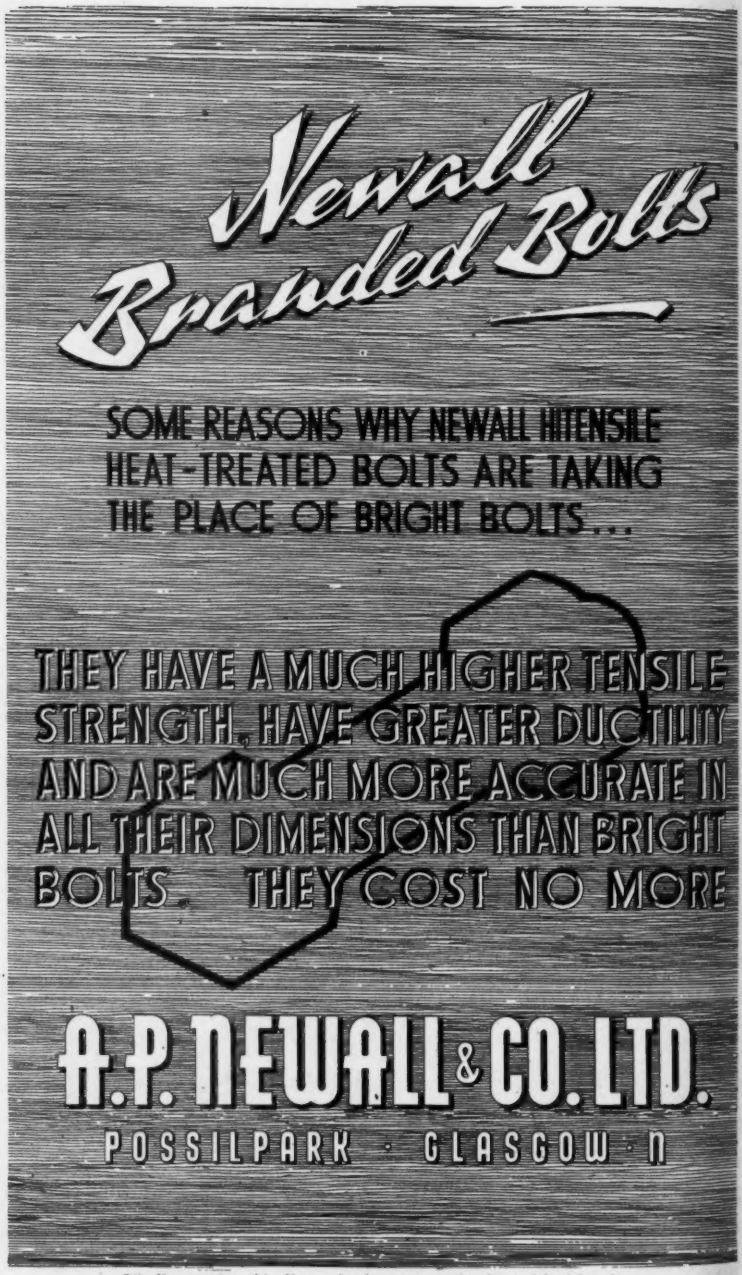
## JOURNALS FOR LIBERATED EUROPE.

The Institute is receiving requests from universities and scientific and technical bodies in the liberated countries of Europe for copies of back numbers of the *Journal* of the Institute. In some cases the contents of libraries were confiscated by the Germans or destroyed.

Unfortunately the Institute is not able to meet these requests as, due to paper restrictions and increased demands, many back numbers are now out of print. It is hoped, therefore, that members who have no further use for their *Journals*, particularly of those issued during the war, will give consideration to the suggestion that they might be prepared to make them available for presentation to libraries in liberated countries.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# INSTITUTE NOTES.

JULY, 1946.

## A YEAR OF COUNCIL.

*General Functions of Council.*

The Council is the governing body elected by members of the Institute to carry on the work of the Institute. It consists of the President, Past-Presidents, Vice-Presidents and twenty-one ordinary members, of whom seven retire each year but are eligible for re-election.

This year, voting took place to fill seven places which became vacant, and four hundred voting papers were returned, resulting in the election of seven, of whom two were new, Members of Council, *i.e.*, Mr. C. Chilvers and Mr. F. L. Garton.

Much of the detailed work of Council is carried on by Committees, of which eleven are standing committees, *i.e.*, Awards, Benevolent, Branches, By-Laws, Education, Election, Engineering, Finance, House, Publications and Standardization. These, with their sub-committees, cover fields of work which go on from year to year.

Special or topical issues are dealt with by *Ad Hoc* Committees or Sub-Committees appointed as needed, such as that dealing with publicity as described later under Publications Committee.

Non-Council members are co-opted to Council Committees as needed where their contributions are of value.

*The Past Year.*

During the past year several issues beyond routine have been very much alive, and have been considered in detail :

1. *Membership Grades of the Institute.*

In 1936 a special committee sat and made recommendations which resulted in changes, in particular in the change of name from Institution of Petroleum Technologists to Institute of Petroleum, and in the grades of membership. The grade of Fellow was introduced to include members of the Institute of high technical qualifications, and the Member grade mainly for non-technical grades.

Last year an *Ad Hoc* Committee was appointed to consider in more detail definitions of membership which would assist the Election Committee in grading applicants for membership. As a result of its deliberations, the following recommendation was made and accepted by Council :

It is desirable to inaugurate an examination sponsored by the Institute for the purpose of issuing a diploma, and, possibly at a later date, to institute a further grade of technical membership to cater for applicants not meeting the exacting requirements for Fellowship.

This year an Education Committee was formed to consider how best this should be done, and discussions held with the City and Guilds Institute of London; it is hoped that in the near future a revised City and Guilds' examination will be available, which will serve the needs of the Institute.

2. *House Committee.*

The House Committee has been considering the question of better facilities for members, which is a matter of great importance but difficult to solve in view of the limited accommodation at Manson House.

The increase in the work of the Institute has made necessary an increase in Staff. A Publications Secretary, Mr. George Sell, has been appointed to take care of publications of the Institute, and a Technical Secretary, Mr. Peter Kerr, to look after the technical activities of the Institute, and in particular the Standardization and Engineering Committees.

3. *Publications Committee.*

A new Sub-Committee is now considering improvements in the scope and layout of the Journal, with the object of improving the non-technical and news section of the Journal. An *Ad Hoc* Committee has been formed with the object of giving members of the Institute and others a better knowledge of the work of the Institute.

The Library Sub-Committee has taken steps to re-house the Library at Manson House from the Adelphi where the books have been kept during wartime, so that the whole of the Library will be available to members of the Institute.

4. *Engineering Committee.*

During the past year, the Engineering Committee has sponsored a Code of Electrical Practice, which is now being prepared for publication.

5. *Branches Committee.*

The Branches Committee has been very active during the year, and has issued a draft constitution for the guidance of Branches, particularly new Branches, and has generally improved and strengthened the ties between the Council and the Branches.

The Northern, Stanlow, and South Wales Branches have each had

a programme of meetings during the year; the Northern Branch held its first post-war social function on March 1, 1946, with a well-attended dinner and dance.

The Scottish Branch recommenced its meetings on April 5, when Professor F. H. Garner gave his presidential address, illustrated by films, to about 120 members and friends at Edinburgh.

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## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

BERRY, William Henry, Erection Superintendent, United British Oilfields of Trinidad. (*J. E. Smith ; S. T. Waite.*)

van BERTSBERGH, Jan Willem Bausch, Geologist, Apex (Trinidad) Oilfields, Ltd. (*A. H. Richard ; H. W. Reid.*)

BRETT, Dennis Arthur, Director, Caleb Brett & Son Ltd. (*E. A. Hunting ; J. V. Delves.*)

BROOK, Conrad Guy, Sales Manager, National Benzole Co. Ltd. (*Thos. F. Laurie ; W. H. Hoffert.*)

BRYSON, Charles Randolph, Technical Officer (Chemist), Imperial Chemical Industries Ltd. (*E. G. Brown ; E. R. H. Davies.*)

EDWARDS, Kenneth Ward, Junior Exploitation Engineer, United British Oilfields of Trinidad Ltd. (*J. E. Smith ; G. F. Hazzard.*)

GRIFFITHS, Frederick Albert Donovan, Maintenance Superintendent, United British Oilfields of Trinidad Ltd. (*S. T. Waite ; J. E. Smith.*)

HICKSON, Charles Robert Tuthill, Geologist, United British Oilfields of Trinidad Ltd. (*S. T. Waite ; J. E. Smith.*)

JONES, Charles Frederick, Assistant Installation Manager, Shell Company of Ceylon Ltd. (*A. E. Hewitt ; A. W. H. Phelps.*)

McCARL, Robert Alick, Assistant Chemist, Anglo-American Oil Co. Ltd. (*C. Chilvers ; F. Tipler.*)

McMURRAN, John, Technical Assistant, Trinidad Leaseholds Ltd. (*A. R. Richards ; G. F. Hazzard.*)

MACNAUGHTON-JONES, Henry Wells, Acting Deputy Manager, Refinery, Trinidad Leaseholds Ltd. (*B. G. Banks ; E. G. Stibbs.*)

NASH, George Charles, Equipment Engineer, United British Oilfields of Trinidad, Ltd. (*J. E. Smith ; S. T. Waite.*)

PARSONS, Philip, Student Apprentice (Engineering), National Oil Refineries Ltd. (*R. B. Southall ; E. J. Horley.*)

PENNELL, Montague Mattinson, Physicist, Anglo–Iranian Oil Co. Ltd. (*A. E. Dunstan ; D. A. Howes.*)

STRADLING, Thomas Eric, Student Apprentice (Engineering), National Oil Refineries Ltd. (*R. B. Southall ; E. J. Horley.*)

WOOLF, Abraham Vernon, Engineer, Lobitos Oilfields Ltd. (*J. C. Wood-Mallock ; A. Cluer.*)

YOUSSEF, Ibrahim, Chief Chemist, Government Refinery, Suez. (*M. Allam ; W. Farag.*)

*Applications for Transfer.*

BAGGS, James Milton, Plant Chemist, The Flintkote Co., Morristown, N.J. (*Student to Associate Member.*)

DOVE, John Henry, Chemist, Anglo–Iranian Oil Co. Ltd. (*A. E. Dunstan ; D. A. Howes.*) (*Student to Member.*)

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## PERSONAL NOTES.

ALEXANDER LOWE MCCOLL, Chairman of the Lubricating Oil Committee of the Petroleum Board, was accorded the honour of Knight Bachelor on the occasion of H.M. the King's Birthday.

SYDNEY GEORGE WRAIGHT, lately manager of Anglo–Egyptian Oilfields, Ltd., refinery at Suez was awarded the O.B.E. in the Birthday Honours List.

MOSTAFA ALLAM, director of the Egyptian Government refinery at Suez, was awarded the Order of the Nile (4th Class) on the occasion of King Farouk's birthday.

MAJOR D. G. PIDGEON, R.A.S.C., has been awarded the M.B.E. (Military) for gallant and distinguished service in Italy.

A. C. HARTLEY has been elected a vice-president of the Institution of Mechanical Engineers.

H. S. EVANS, G. JONES, W. MCCARTHY, J. D. MCHAY, W. R. THOMAS and S. J. WILLIAMS were successful in gaining the National Certificate in Chemistry as the result of recent examinations.

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## FIELD AND REFINERY DEVELOPMENTS.

Members or others engaged in oilfields and refineries are specially invited to forward notes on any matters of general interest to petroleum technologists. Particulars of any unusual phenomena or occurrences met with by geologists, surveyors, engineers or field operators would be welcomed by the Council with a view to incorporation in the Journal. Photographs or sketches illustrating any descriptions or showing interesting or exceptional occurrences

would likewise prove acceptable either for publication or permanent record in the Library of the Institute.

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## DONATIONS BY BATAAFSCHE IN HOLLAND.

Recently N.V. De Bataafsche Petroleum Maatschappij, The Hague, Holland, made donations, totalling more than four million guilders (about £400,000) to the Universities of Leyden and Delft and to the Scholarship Fund, to be distributed as follows :

One million guilders for building and fitting up a Physical Laboratory for the University of Leyden, in order to renew the famous Kamerlingh Onnes Laboratory (managing directors Prof. Dr. W. J. de Haas, Prof. Dr. H. A. Kramers and Prof. Dr. C. J. Gorter).

It is the intention that this laboratory should be provided with the most modern equipment for obtaining low temperatures and that it should be in a position to maintain the traditions of the Kamerlingh Onnes Laboratory, *i.e.*, the fundamental research into the properties of materials at different temperatures, and that students will find there an opportunity of studying in particular the theory of heat.

One million guilders for building and fitting up a Laboratory for Physical Technology (managing director Prof. Dr. W. J. D. van Dijck) at the Technical University of Delft, in which students will be in a position to acquaint themselves, theoretically as well as practically, with the " unit operations " in the oil and chemical industry.

One million guilders for the extension and fitting up of the Laboratory for Chemical Technology (managing director Prof. Dr. H. I. Waterman) at the Technical University of Delft, in which students can acquaint themselves in a practical way with the technical realization of the most important " unit processes " in the chemical industry.

Furthermore, Bataafsche has instituted for the next five years a number of scholarships for students of all Netherlands Universities. Each year during the next five years twenty graduate-students in chemistry, physics and geology, will receive a scholarship for a maximum of four years, amounting to f. 2,000 annually, with special allowances for travelling abroad. A total amount of more than one million guilders has been allocated for this scheme.

# BABCOCK DETROIT ROTOSTOKER

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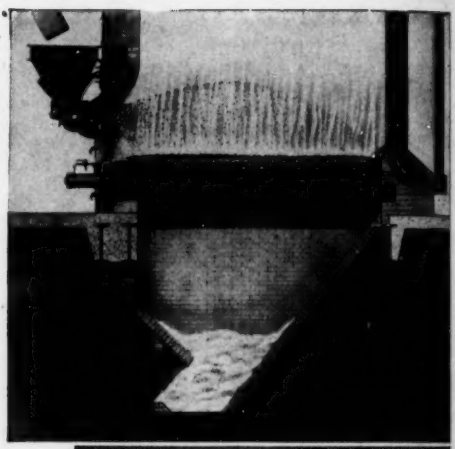

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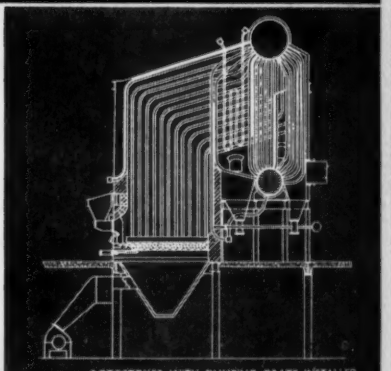

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# INSTITUTE NOTES.

AUGUST, 1946.

## INSTITUTE MEETINGS.

SESSION 1946–47.

The following meetings have been tentatively arranged for the next Session, and the full programme will be issued in due course.

| | |
|---|---|
| 1946 | |
| October 15. | "The Lubrication of Pre-selective Gear Boxes." A. T. Wilford, B.Sc., A.R.C.S., A.R.I.C. (Fellow). |
| November 12. | "Aerial Photography applied to Exploration for Oil." Dr. N. J. M. Taverne. |
| December 11. | Symposium on Oil Fires:<br>"Wartime Oil Fires and Lessons." E. P. Lancashire.<br>"Burning of Fuel and Other Oils." D. Burgoyne.<br>"Foam." R. N. O. Clarke. |
| 1947 | |
| January 8. | "Petroleum Products in Agriculture. The Rôle of Petroleum in Plant Protection." L. W. Leyland Cole, M.Sc., B.Sc.(Agric.), F.R.I.C. |
| February 12. | "Fuels and Lubricants for Aero Gas Turbines." C. G. Williams, D.Sc., M.I.Mech.E., A.F.R.Ae.S. (Fellow). |
| March 12. | "Modern Developments in Geophysical Prospecting." Ir. A. van Weelden. |
| April 9. | "Aromatization." Dr. H. Steiner. |
| May 7. | "The Development of Hydrogenation and Fischer-Tropsch Processes in Germany." Major K. Gordon (Fellow). |
| June 11. | "Use of Petroleum Products in Printing Inks, etc." Dr. C. H. Healey and Dr. L. Ivanovsky (Fellow). |

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## FUEL AND THE FUTURE.

MINISTRY OF FUEL AND POWER CONFERENCE.

The Fuel Efficiency Committee of the Ministry of Fuel and Power have arranged a fuel efficiency conference to be held at the Central Hall, Westminster, S.W.1 on Tuesday, Wednesday and Thursday, October 8, 9 and 10, 1946. Among the speakers at the opening session at 11.0 a.m. on October 8 are the Rt. Hon. E. Shinwell, M.P., and the Rt. Hon. Aneurin Bevan, after which the conference will split up into eight sections running concurrently. These are:—

Section A—The Generation of Steam.
" B—Steam Utilization.
" C—Heat for Drying.
" D—High Temperature Processes.
" E—The Carbonization and Chemical Industries.
" F—Special Industrial Sessions.
" G—Modern Heating and the Architect.
" H—The Home and its Fuel Service.

The Institute of Petroleum has accepted an invitation to organize a session on "Oil Firing", commencing at 3.45 p.m. on Wednesday, October 9, in Section D of the Conference. The Chairman at this

Session will be Professor F. H. Garner, O.B.E., who, in conjunction with members of the Liquid Fuel Installations Committee of the Institute, is making the necessary preparations. Tentative arrangements have been made for the presentation of a paper on "Liquid Fuels for High Temperature Processes" by T. C. Bailey, F. J. Battershill and R. J. Bressey.

Admission to the Conference is *by ticket only*. Members of the Institute who wish to attend and *have not received an invitation from any other source* should apply for tickets direct to :—

Ministry of Fuel and Power,
Queen Anne's Chambers,
Dean Farrar Street,
London, S.W.1.

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## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

BAILEY, Thomas Cyril, Technical Assistant, Petroleum Board. (*R. J. Bressey ; G. R. Llewellyn.*)

EL-DISSOUKI, Ibrahim, Chemist, Anglo-Egyptian Oilfields, Ltd. (*W. R. P. Hodson ; P. G. Higgs.*)

FORBES, Robert James, Chemical Engineer, Royal Dutch-Shell Group. (*J. S. Jackson ; N. Hyams.*)

GOODCHILD, Edmund Arthur, Chief Metallurgist and Chemist, Hoffmann Manufacturing Co. Ltd. (*J. Mason ; H. S. Garlick.*)

IGGULDEN, Ronald Dorji, Head Office Inspector, Petroleum Board. (*E. P. Lancashire ; H. F. Jones.*)

KING, Francis Robert Benjamin, Technical Assistant, Petroleum Board. (*T. K. Hanson ; R. Sefton.*)

LEA, Herbert, Manager, Midland Region, Lubricating Oil Pool, Petroleum Board. (*H. Baker ; H. C. S. Fothergill.*)

POUNDER, George Dick, Assistant Engineer, Iraq Petroleum Co. Ltd. (*L. J. Le Mesurier ; C. V. Hill.*)

PRITCHARD, Frank, Office Manager, British Oilfield Equipment Co. Ltd. (*N. Matheson ; S. L. Witard.*)

ROBINSON, Samuel, Laboratory Manager, Trimpell Ltd. (*P. M. Griffiths ; E. LeQ. Herbert.*)

WHALLEY, Harold Kenneth, Head of Chemical Research Department, Manchester Oil Refinery Ltd. (*E. J. Dunstan ; G. H. Harries.*)

WHORTON, John Charles, Trainee, Lobitos Oilfields Ltd. (*J. Alderson ; L. McGrath.*)

WILSON, George Edward, Divisional Chemist, L.M.S. Railway Company. (*S. J. M. Auld ; E. A. Evans.*)

*Applications for Transfer.*

BRUNNER, Donald George, Major, R.E.M.E. (*T. G. Hunter ; A. H. Nissan.*) (*Student to Associate Member.*)

GEORGE, Henry Ridyard, Captain, H.M. Forces. (*T. G. Hunter ; A. H. Nissan.*) (*Student to Associate Member.*)

## ROYAL CHARTER FOR INSTITUTE OF FUEL.

We are pleased to announce that the Institute of Fuel has been granted a Charter by H.M. the King.

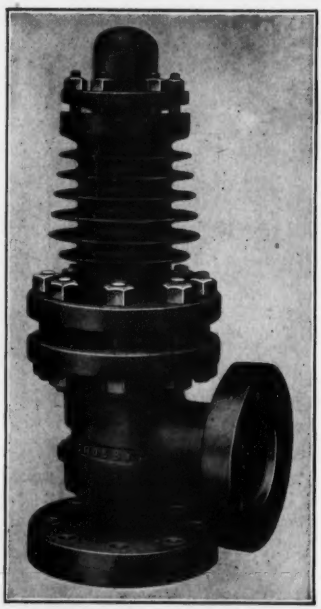
## THE CENTENARY OF THE CHEMICAL SOCIETY.

The Chemical Society is to celebrate the centenary of its foundation in July 1947. But for the war the celebrations would have taken place in 1941, for it was " on the 23rd February, 1841, that twenty-five gentlemen interested in the prosecution of chemistry met together at the Society of Arts to consider whether it be expedient to form a Chemical Society ".

The Fellowship of the Society has grown from those twenty-five gentlemen in 1841 to over 6,000. The study of chemistry as a whole has remained its object ; because of this the Society has always maintained a special place in the world of chemistry.

The science of chemistry has made great advances since 1841 ; a glance through the list of Presidents of the Society provides convincing evidence of the important part played by its Fellows—to name but a few, Graham, Hofmann, Williamson, Edward Frankland, Odling, Gilbert, Sir William and W. H. Perkin, Crookes, Ramsay, Dewar, Armstrong, Meldola and Pope—every one of these is associated with fundamental chemical discoveries of far-reaching importance.

The discovery of mauve by Perkin is an example of the way in which the work of the research chemist may have a profound influence on social and economic development. From this early discovery has grown the whole of the present-day coal tar industry embracing dyestuffs manufacture, synthetic medicinals, the photographic industry and much more. The pure research on the growth of plants by Gilbert and Lawes at Rothamsted formed the basis of the vast present-day synthetic fertiliser industry, the importance of which in the production of food needs no emphasizing in a hungry world. Every day we can see evidence of the work of men like Crookes, Dewar and Ramsay. The cathode ray tube of Crookes is the direct ancestor of our television screens, the thermos flask of Dewar is one example of the application of Dewar's low temperature experiments and neon display signs are but one instance of the use man has made of Ramsay's epoch-making discovery of the rare gases. Innumerable instances of benefits to mankind from the discoveries made by the Fellows in their original researches can be cited from the rich, proud history of the Society.



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# INSTITUTE NOTES.

SEPTEMBER, 1946.

## INSTITUTE MEETINGS.

| | |
|---|---|
| 1946 | |
| October 16. | "The Lubrication of Pre-selective Gearboxes." A. T. Wilford, B.Sc., A.R.C.S., A.R.I.C. (Fellow). |
| November 12. | "Viscometry of Hydrocarbon Soap Systems." F. H. Garner, O.B.E., Ph.D., F.R.I.C. (Fellow), Alfred H. Nissan, D.Sc. (Fellow) and G. F. Wood, Ph.D. |
| December 11. | Symposium on Oil Fires: "Fires and Explosions at Oil Installations." E. P. Lancashire (Member). "Experiments on Rate of Foam Application." N. O. Clarke, E. Thornton, B.Sc., F.R.I.C. (Fellow) and J. A. Lewis. "Behaviour of Oils Burning in Open Reservoirs and Effects of Air Agitation." J. H. Burgoyne. |
| 1947 | |
| January 8. | "Petroleum Products in Agriculture. The Role of Petroleum in Plant Protection." L. W. Leyland Cole, M.Sc., B.Sc. (Agric.), F.R.I.C. |
| February 12. | "Fuels and Lubricants for Aero Gas Turbines." C. G. Williams, D.Sc., M.I.Mech.E., A.F.R.Ae.S. (Fellow). |
| March 12. | "Modern Developments in Geophysical Prospecting." Ir. A. van Weelden. |
| April 9. | "Aromatics from Petroleum." Dr. H. Steiner. |
| May 7. | "The Development of Hydrogenation and Fischer-Tropsch Processes in Germany." Major K. Gordon (Fellow). |
| June 11. | "Use of Petroleum Products in the Printing Ink and Allied Industries." Dr. A. C. Healey and Dr. L. Ivanovsky (Fellow). |

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## ELECTION TO COUNCIL.

The attention of members is drawn to the following extracts from the By-Laws governing election to the Council of the Institute :—

(*a*) The Council of the Institute shall be chosen from the Fellows and Members only.

(*b*) Every Fellow, Member, and Associate Member of the Institute may send in writing to the Council the name of a Fellow or Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Fellows, Members, or Associate Members and delivered to the Secretary not later than 30th day of November in any year. No Fellow, Member, or Associate Member may sign more than one Nomination Paper in any one year.

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## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by

letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

BAILLIE, Robert Brendan, Chief Technical Officer, Victoria Branch, Shell Company of Australia, Ltd. (*H. A. Banks ; G. W. Sheel.*)

BENTALL, Walter, Squadron Leader (Engineer), R.A.F. (*E. Thornton ; F. D. Edwards.*)

BIDSTRUP, Tom Julius, Technical Officer, Shell Company of Australia, Ltd. (*H. A. Banks ; G. W. Sheel.*)

DOBNER, Karl M. I. Chief Mechanical Engineer, Compania Petrolera Lobitos, Peru. (*C. Barrington Brown ; A. T. Beazley.*)

GREENSHIELDS, Robert John, Chief Research Engineer, Shell Oil Company, Inc., Illinois. (*J. A. Oriel ; F. L. Garton.*)

JARROTT, Stanley Keith, Clerk, Vacuum Oil Company, Ltd., Brisbane, Australia.

MCLAREN, Arthur Andrew, Flight Lieutenant (Engineer), R.A.F. (*E. Thornton ; F. D. Edwards.*)

MANSFIELD, William James, Process Plant Foreman, Manchester Oil Refinery, Ltd. (*E. J. Dunstan ; E. S. Sellers.*)

WHIPP, Roger Henry, Squadron Leader, R.A.F. (*E. Thornton ; F. D. Edwards.*)

YOUNG, Frederick William, Flying Officer, R.A.F. (*E. Thornton ; F. D. Edwards.*)

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## PERSONAL NOTES.

G. W. LEPPER who has been, since 1936, technical adviser on oil exploration and development to the Petroleum Department, now the Petroleum Division of the Ministry of Fuel and Power, retired from the Government service on July 7. He has rejoined the London staff of the Burmah Oil Co. Ltd. DR. W. L. F. NUTTALL, formerly of the geological department of the Bataapsche Petroleum Maatschappij has been appointed to succeed Mr. Lepper at the Ministry.

PROF. A. O. RANKINE has been appointed a member of the Committee set up by the Minister of Fuel and Power to inquire into the resources and development of Britain's metalliferous and other minerals.

COMDR. H. V. LAVINGTON has recently been appointed to the board of the Trinidad Petroleum Development Co. Ltd. He has been the company's general manager in Trinidad for a number of years.

THOMAS H. G. BRAYFIELD, who has been recuperating in Canada following his release from internment in Japanese hands, has recently arrived in England.

## LUNCHEON TO DR. A. E. DUNSTAN.

On July 11, 1946, Dr. A. E. Dunstan, who resigned as Honorary Editor at the end of 1945, was the guest of honour at a luncheon given by Members of Council of the Institute. The Chair was taken by Prof. F. H. Garner, O.B.E., Honorary Editor.

Prof. F. H. Garner: We are here today to pay a special tribute to Dr. Dunstan; his outstanding work in petroleum science has been recognized by the award of the Redwood Medal, but today we have met to recognize the all-important part he has played in establishing the publications of the Institute and to celebrate his Jubilee as Honorary Editor of its publications. At the time of his retirement he had been Honorary Editor for 25 years, for it was in 1921 that he took over after a short period as Honorary Associate Editor to the late W. H. Dalton.

In those 25 years Dunstan has done much to advance the prestige of the Institute. He took over the *Journal* when it was a modest quarterly publication and quickly brought it to a regular monthly of considerable importance in petroleum literature. He instituted the Abstract Section, the value of which has proved inestimable throughout the industry. He also initiated the "Annual Reviews of Petroleum Technology"—and it was only a world war which caused their temporary suspension.

But it was not only in these periodical publications that Dr. Dunstan has served the Institute so well, for every one of the varied books—from the "Crystal Palace Lectures" to "Tables for the Measurement of Oil"—bore testimony to the genius of Dunstan.

It only remains for me, concluded Prof. Garner, to express the thanks of all Members of Council to Dr. Dunstan for his untiring efforts in the past 25 years and to wish him many years of health and happiness.

Tributes to the work of Dr. Dunstan were paid by several other speakers, Mr. T. Dewhurst particularly referring to him as the inspiration behind the First World Petroleum Congress, while Prof. J. S. S. Brame said that Dr. Dunstan had rendered to the Institute greater service than any other person and had established a world-wide reputation for the Institute and its *Journal*, particularly in the United States. Mr. George Sell said he was happy to recall the many years of his close association with Dr. Dunstan in the service of the Institute. To him Dr. Dunstan had always been a valued guide and philosopher as well as an inspiration.

Dr. A. E. Dunstan: I was reading the other day in "Pilgrim's Progress" "*As I walked thro' the wilderness of this world I lighted on a den and I laid me down and slept and as I slept I dreamed a dream.*"

Few dreams come true. Now and again one does and this is one of them. I go back to the day 26 years ago when Sir Boverton Redwood asked me to take on the *Journal* with Dalton. I cannot think of any dream that in later years came true to give me so much happiness as that request.

It was a very simple *Journal* in those days. The I.P.T. was then very small, but what it lacked in numbers of membership it made up for with their enthusiasm and energy. They were good *Journals* admittedly and I did my best to live up to Dalton's traditions.

It was then only a quarterly with no abstracts; but things moved and gradually it got larger and more frequent. Then came the abstracts, the "Crystal Palace Lectures," the first "Standard Methods" and "Petroleum—25 Year's Retrospect." I gained the reputation of being a reckless spender. But "*what shall it profit a man in a Society if he gains the whole world and lose his own soul?*" So we agreed to spend.

Looking back, one must express one's indebtedness to the extremely valuable help received from those who I have been so fortunate to have as colleagues. I would specially mention my old friend George Sell. He it was who perhaps more than anyone else kept the *Journal* alive and laid the foundations of what a scientific journal should be. My thanks are also due to Miss Tripp, to Mr. Noble and to the secretaries of the Institute—Stokes Rees, Astbury, Coe—all of them full of enthusiasm and help.

Now the mantle of Elisha falls upon Prof. Garner. No one has served the Institute better as Honorary Associate Editor, Chairman of the Standardization Committee, and President. It is due to him that the "Annual Reports" have attained their present fame and in his hands the Institute's publications are safe.

On such an occasion as this I must emphasize the extraordinary aid I have received from voluntary helpers. I cannot think how such a society as this could exist without this voluntary help. To quote Plato: "*The aim of a veritable community is not that this man or that should prosper but that the whole should flourish.*"

We all owe a debt to the directors of our various companies who allow us to spend much official time on Institute committees. We should praise them for this unselfish attitude.

What more can I say? Only this. I have done what I could to perpetuate what Sir Boverton Redwood asked me to do and it is a pleasure, an incomparable pleasure, to be the recipient of such remarks as have been expressed on this memorable occasion. I shall always cherish the memory.

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## LUNCHEON TO DR. G. EGLOFF.

On August 12 Dr. Gustav Egloff was entertained at luncheon by the Council of the Institute. Mr. G. H. Coxon, chairman of Council, presided.

Mr. G. H. Coxon: We are all pleased to see Dr. Egloff again, to shake hands with him and to welcome him. For many years he has been a good friend to the Institute and has done much for it in the United States. He has a great reputation as an oil technologist and an expert on petroleum patents and had written more articles

on petroleum technology than probably any other individual. Although small in stature he is big in mind and we are very happy to meet him once more.

Dr. A. E. Dunstan: The last time I had the pleasure of welcoming Dr. Egloff was in 1937 and I am sure that we are all delighted to have him with us. I first met him in 1921 and even in those distant days he was a man who mattered in petroleum technology.

It has been estimated that if all Dr. Egloff's publications were burnt there would be produced sufficient calories to raise the *Queen Mary* one inch in her dock. I like to think of Egloff as a man in evening dress. Take off the evening dress and you have Egloff the man—decent, honorable, friendly, kindly.

Dr. G. Egloff: Friends, it is nine years since I last had the opportunity of foregathering with you. That is nine years too long. Meanwhile the world has changed in many ways; the oil industry has been so revolutionized that to-day the individual cannot follow it. There is a need for specialization and the larger companies, and some smaller ones, are expanding their research facilities into the chemical field at a high rate. On the other hand, the chemical manufacturers are taking yet larger quantities of oil products for conversion into chemical products. But the question is where are the staffs coming from? The United States is short of 20,000 scientific and technical brains.

The United States is geared to a higher research tempo than ever before, particularly in regard to rocket fuels and the knowledge of atomic energy. One cannot pay too much for new knowledge and fundamental research.

In conclusion, Dr. Egloff said he was deeply grateful for the opportunity of again meeting his friends and colleagues in England.

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## FUEL ECONOMY CONFERENCE, 1947.

By invitation of the Netherlands National Committee, the Fuel Economy Conference of the World Power Conference will be held at The Hague, Holland, from 2nd–10th September, 1947. During this Conference, an Official Visit of two days will take place to the Netherlands State Coal Mines, at Lutterade. Intending participants from Great Britain are invited to apply for further particulars to: British National Committee, World Power Conference, 36, Kingsway, London, W.C.2.

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## LIBRARY RULES.

1. The Library is open for reference and for the issue and return of books from 10 a.m. to 5 p.m. daily, excepting Saturday.

2. Members of the Institute are permitted to borrow up to two books at a time for a period not exceeding a fortnight. In special circumstances an additional number of books may be borrowed at the discretion of the Librarian.

3. Dictionaries and works of reference are not available for loan.

4 A new book may not be taken out of the Library until one month after it has been received.

5. Books must not be borrowed from the Library until the register has been signed by the borrower.

When a book is required to be forwarded, a signed request must be sent to the Librarian and the return cost of carriage paid. All books forwarded are at the risk of the borrower until returned, and when returned through the post must be registered and securely packed to prevent injury.

6. Books may not be sent or taken out of the United Kingdom.

7. Current unbound journals and periodicals of which there is only one copy in the Library may not be borrowed.

8. A borrower retaining books longer than the time specified, or failing to return them when demanded, shall forfeit the right to borrow books until all those standing against his name have been returned. Books not returned within two weeks of a demand will be replaced at the expense of the borrower.

Borrowers to whom books have been issued are responsible for their preservation from injury and their safe custody. If a book is found damaged on return, it shall be repaired or replaced at the expense of the borrower.

9. Persons requiring photostat copies of extracts from books or periodicals may obtain these on application to the Librarian and on payment of the appropriate charges.

# INSTITUTE NOTES.

OCTOBER, 1946.

## "OIL FIRES."

During the late war much contact occurred between "Fire Fighters" in general and "Oil Men," who fight rare peace-time fires "incidentally." Much good has accrued from these contacts and many lessons are to be learned from "experience" and "experiments."

At the Meeting of the Institute on December 11, which incidentally creates a precedent in being a joint meeting with the Institution of Fire Engineers, the "experience" is being well presented by Mr. E. P. Lancashire, who was active on behalf of the Petroleum Board in most major war-time oil fires. "Experiment," with most interesting results, is presented for Lord Falmouth's Department by Dr. Burgoyne and Mr. N. O. Clark.

Do *you* know what *really* happens when a pool of oil burns ? ? ?

Extra effort to attend will be well repayed and will help to ensure good discussion.

Preprints will be available on application to the Secretary.

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## STUDENTS' SECTION (LONDON BRANCH).

After a lapse of six years the London Branch of the Students' Section is resuming its activities. In order that its programme shall be representative of the wishes of all members an exploratory meeting has been arranged for 6 p.m. on Monday, November 18, 1946, at Manson House, 26, Portland Place, London, W. 1. Light refreshments will be provided at 5.30 p.m.

Through the courtesy of the Anglo-Iranian Oil Co., Ltd., a visit to the Eakring Oilfields has already been arranged; details will be announced at the meeting. Any further information can be obtained from N. E. F. Hitchcock, Stifford Cottage, High Street, Cranford, Middlesex. (Telephone : Hayes (Middx.) 1278.)

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## INSTITUTE OF PETROLEUM ELECTRICAL CODE.

A suggested Code of Electrical Practice applicable to conditions in the petroleum industry has recently been issued by the Institute of Petroleum. A survey of current practices disclosed that a considerable diversity prevailed, particularly on oilfields, and to a

lesser extent in refineries and installations overseas. There was thus a general demand in the industry for a document such as this Code which would be representative of the considered views of the industry itself based on experience of its special conditions and which would give general guidance on the selection and methods of installation of suitable electrical equipment for each type of operation encountered. It was felt that this would be helpful also to British manufacturers interested in supplying its needs.

The Code embodies the results of an examination by a committee of engineers of the practice adopted by the major British oil companies, and also of Codes of Practice, Regulations and legal requirements applicable to the industry both in Great Britain and abroad, including in particular various American codes and publications.

Account has been taken where appropriate of the Codes of Practice and Standard Specifications produced by such British authorities as the Institution of Electrical Engineers, British Standards Institution, the Ministry of Fuel and Power, and the Factories Department of the Ministry of Labour and National Service.

The scope of the Code is somewhat wider than is usual in codes of this kind, since its field of application embraces conditions and operations throughout the industry from the oil well to the delivery of finished products. Furthermore, it is not confined to offering guidance in regard to the use of electricity for lighting, power and instruments, but takes account also of the problems arising from accumulations of static electricity which may be produced in certain operations in the industry, and also of protective measures that may be taken against the effects of electricity in the form of lightning.

Whilst the Rules and Recommendations embodying the practice suggested in the Code are comparatively brief, a number of schedules are included to describe and explain the arguments upon which these are based. One of these reviews the incidence of risk of a fire arising from electrical causes and discusses preventive measures, and attempts to classify in a logical manner the conditions giving rise to such a risk and the areas over which dangerous conditions may be considered to exist. Another schedule deals at some length with the question of the generation of static electricity. Another gives notes on protection against lightning. The suggested Rules are divided into groups, for each of which there is a corresponding explanatory schedule, and it is considered that these explanatory schedules should therefore not only facilitate the interpretation of the Rules, but enable suitable practice to be adopted in regard to unusual applications of electricity that may arise from time to time.

In a foreword to the Code the Council of the Institute point out that it represents their present views and is issued provisionally at this stage with a view to experience being gained in its application, after which it will be reviewed and either confirmed or amended as may then be found desirable.

The price of this 77-page publication is 5*s*., post free, and copies are obtainable from the offices of the Institute.

## ELECTION TO COUNCIL.

The attention of members is drawn to the following extracts from the By-Laws governing election to the Council of the Institute :—

(*a*) The Council of the Institute shall be chosen from the Fellows and Members only.

(*b*) Every Fellow, Member, and Associate Member of the Institute may send in writing to the Council the name of a Fellow or Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Fellows, Members, or Associate Members and delivered to the Secretary not later than 30th day of November in any year. No Fellow, Member, or Associate Member may sign more than one Nomination Paper in any one year.

---

## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-Laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

AL-ANWAR, Mohamed Salah Eddine, Engineer, Shell Company of Egypt, Ltd., Alexandria. (*H. A. Blackmore ; D. R. Howgill.*)

BICKERTON, Richard Samuel, Engineer, Matthew Wells & Co., Ltd. (*V. H. Stott ; M. Mason.*)

BROCK, Thomas Arthur, Junior Technical Assistant, Anglo-Iraniun Oil Co. Ltd. (*W. H. Thomas ; A. R. Javes.*)

CLARKE, Albert Edward, Research Chemist, Joseph Lucas Ltd. (*F. H. Garner ; A. H. Nissan.*)

FITZGERALD, Patrick, Company Director & Sales Manager, Southern Capital Oil Co. Ltd. (*J. H. Varley ; R. R. Dunn.*)

HUGUIN, Eugene Louis Pierre, Director General, Societe miniere des schistes bitumineux. (*W. A. Keightley ; A. E. Dunstan.*)

JONES, Ernest James, Accountancy Assistant, National Oil Refineries Ltd. (*R. B. Southall ; E. Thornton.*)

LLOYD, Ronald Edgar, Assistant District Operator, Petroleum Board. (*C. Chilvers ; R. D. Streeton.*)

NELLENSTEYN, Frederik Jan, Director of the State Road Laboratory, The Hague, Holland.

NISBET, Hugh Bryan, Professor of Chemistry, Heriot-Watt College, Edinburgh. (*R. Crichton ; S. J. M. Auld.*)

NUTTALL, Alfred Laurence Falkiner, Petroleum Geologist, Petroleum Division, Ministry of Fuel and Power. (*T. Dewhurst ; G. W. Lepper.*)

STOTHARD, Thomas Hall, Research Section Leader, British Celanese Ltd. (*G. M. Dyson ; A. W. Pottier.*)

TAIT, Keith Gordon, Constructional Engineer, United British Oilfields of Trinidad Ltd. (*R. D. Crook ; W. R. P. Hodgson.*)

WHYTE, Daniel, Lubrication Engineer, Anglo-Iranian Oil Co. Ltd. (*S. J. M. Auld ; E. R. Blane.*)

### *Applications for Transfer.*

AULT, William Sinclair, Chief Technical Adviser, Shell-Mex and B.P. Ltd. (*J. A. Oriel ; E. LeQ. Herbert.*) (*Member to Fellow.*)

CARDER, William Aubrey, British Mexican Petroleum Co. Ltd. (*H. C. Tett ; H. F. Jones.*) (*Student to Associate Member.*)

CASTLE, Arthur Frederick, Assistant Production Superintendent, Apex (Trinidad) Oilfields Ltd. (*A. H. Richard ; H. W. Reid.*) (*Associate Member to Member.*)

---

## NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, paras. 9 and 10.

*As Fellows.*

COURTAN, Maurice M.
GOLLIN, G. J.
MAXWELL, G. B.
MEAD, Brian.
SALOMON, Tobie G.

*Transfers to Fellow.*

JAVES, A. R.
MOORE, P. H.
THORPE, T. C. G.

*As Members.*

BADDILEY, J. R.
BIDDOLPH, G. W. J.
FOTHERGILL, H. C. S.
SMITH, Clement G.

*Transfer to Member.*

BALFOUR, N. R.

*As Associate Members.*

BOON, Cyril B.
BROOKS, Roy.
BUTLER, A. H. S.
DAY, S.
FIRMINGER, John.
HALL, P. C.
HOLMES, G. W. D.
JAGGER, H.
JENNISON, J. A.
LANGSTON, R. P.
LITHERLAND, F. W.
MILLER, W. G.
REES, L. M. J.
STROUD, H. J.
WALKER, A.
WILLIAMS, H. D.

*Transfers to Associate Member.*

BOWKER, Thomas D.
PARR, R. W.
PERKS, J. G.

*As Student.*

PAUL, P. F. M.

---

## PERSONAL NOTES.

H. D. FLETCHER, M.I.Mech.E. (Member), attorney and general manager of Apex (Trinidad) Oilfields, Ltd., is retiring this year after twenty-three years with the company.

He joined the company in 1923 as assistant manager and field superintendent and was appointed to his present position in 1937. He will be succeeded by L. A. Bushe (Member).

## SILVER JUBILEE OF AGWI PETROLEUM CORPORATION, LTD.

Founded in 1920, the Agwi Petroleum Corporation Ltd. should have celebrated its Silver Jubilee last year, but the function was delayed until September 6, 1946, and this enabled most of the ex-service men to be present.

Mr. H. D. Demoulins, a Director, presided over the gathering of around 500 in the Guildhall at Southampton. Mr. Demoulins referred briefly to the history of Agwi and to the fact that one of the earliest processes operating at the refinery was vapour-phase cracking, with which the name of Sir Oliver Lodge was associated.

Referring to the Fawley Refinery, Mr. Demoulins expressed the Board's admiration for the loyalty and devotion shown by the staff during the blitz period. With regard to Agwi's part in the war effort, he said that in the 15-months from D-Day they had handled 2-million tons of oil products and received and bunkered over 2,000 ships. He also mentioned that Fawley had been a base for Pluto and the southernmost point of the British pipeline system.

Concluding, Mr. Demoulins said that post-war problems would take them into a wide field, and that the Fawley refinery had an important contribution to make to the national economy.


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# INSTITUTE NOTES.

NOVEMBER, 1946.

## AMERICAN AWARD TO SIR ANDREW AGNEW.

Sir Andrew Agnew, C.B.E., President of the Institute, has been awarded the American Medal of Freedom with Silver Palm for "exceptionally meritorious achievement which aided the United States in the prosecution of the war against the enemy in Continental Europe, as Chairman of the Petroleum Board, from August 1942 to May 1945. He displayed marked leadership, sound knowledge and outstanding ability in expediting necessary petroleum supplies to both the British and American forces. Because of his tenacity of purpose, his close and understanding co-operation with American authorities and his helpfulness in providing many of the necessary warehouse and transportation facilities, American operational requirements were met in a minimum of time and with a maximum of efficiency, thus contributing in large measure to the success of the war effort."

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## SCOTTISH BRANCH.

The Scottish Branch of the Institute of Petroleum held its first meeting of the current session in the Hall of the Pharmaceutical Society, Edinburgh, on October 11, 1946, Mr. Robert Crichton, Chairman of the Branch, presiding.

Mr. A. C. Hartley, C.B.E., Vice-President, delivered a lecture on "Operation Pluto" to an audience of about 120, including visitors from local chemical and engineering societies and employees of the Petroleum Board.

---

## PERSONAL NOTES.

NORMAN F. BROWN (Fellow) has recently terminated his post as Fields Chief Engineer of the Indo-Burma Petroleum Co. Ltd., to take up the position of Director and Technical Manager of the N.F.B. Displacement Pump Co. Ltd.

G. E. ROSE, who first joined the firm of B. & R. Redwood in 1895 and was taken into partnership by the late Mr. Robert Redwood fifteen years ago, died on October 15, 1946, after a short illness. He was a well-known figure in the oil measurement world and his passing will be regretted by many on British storage and similar installations.

## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

ARCHER, Geoffrey Thyne Valentine, Distribution Trainee, Anglo-Iranian Oil Co. (*A. E. Dunstan ; R. B. Southall.*)

CHISHOLM, Archibald Hugh Tennent, General Department, Anglo-Iranian Oil Co. (*H. Medlicott ; G. H. Coxon.*)

CODY, Cecil Thomas Kingsborough, Distribution Trainee, Anglo-Iranian Oil Co. (*A. E. Dunstan ; R. B. Southall.*)

COLLIER, Kenneth Dowsett Gould, Director of Equipment, Air Ministry. (*J. Mason ; E. LeQ. Herbert.*)

EYRES, John James, Director, Alfred Hopps, Sons & Co., Ltd., Liverpool. (*E. R. Redgrove ; S. H. Bean.*)

HOWE, Harry Guy, Distribution Trainee, Anglo-Iranian Oil Co. (*A. E. Dunstan ; R. B. Southall.*)

JACK, Thomas Anthony Maclean, Distribution Trainee, Anglo-Iranian Oil Co. (*A. E. Dunstan ; R. B. Southall.*)

MAPSTONE, George Edward, Chief Chemist, National Oil Pty. Ltd., Australia. (*B. A. Raper.*)

MITCHELL, Derek Fenton, Distribution Trainee, Anglo-Iranian Oil Co. (*A. E. Dunstan ; R. B. Southall.*)

MITCHELL, William Arthur, Laboratory Assistant, Lobitos Oilfields Ltd. (*V. Biske ; F. S. Archer.*)

NIGHTINGALE, John Charles, Distribution Trainee, Anglo-Iranian Oil Co. (*A. E. Dunstan ; R. B. Southall.*)

STILLMAN, Herbert, Technical Representative, Edward Joy & Sons, Ltd., Leeds. (*T. J. Metcalf ; R. Todd.*)

WALKER, Kay John Seymour, Assistant Research Engineer, Anglo-Iranian Oil Co. (*E. T. C. Spooner ; H. Thirkhill.*)

WELFARE, Ivy Marjorie, Chemist in charge (Liverpool Works), C. C. Wakefield & Co., Ltd. (*G. H. Thornley ; E. A. Evans.*)

WRIGHT, Herbert, Drilling Engineer, The Uganda Government. (*M. Robertson.*)

YRIBERRY, Eduardo Jorge, Engineer, Shell-Mex Chile Ltd. (*R. G. Mitchell ; S. Hunn.*)

### *Application for Transfer.*

HORNE, Donald, Research Chemist, British Diesel Oil & Petrol Co., Ltd. (*G. S. Pound ; B. W. Smith.*) (*Associate Member to Member.*)

# INSTITUTE NOTES.

DECEMBER, 1946.

## MEMBERSHIP.

The Institute of Petroleum is anxious to contact members whose association with the Institute has been interrupted during the war years. The Council request that those members, whose association with the Institute has lapsed, communicate with the Institute as soon as possible. In view of the many difficulties experienced in connection with the payment of subscriptions the Council will do all possible to assist as regards the arrears accumulated under war-time conditions.

---

## SCOTTISH BRANCH.

A meeting of the Scottish Branch of the Institute was held at the Royal Technical College, Glasgow, on November 15, the Chair being taken by Mr. Robert Crichton, Branch Chairman.

A paper on "A Brief Survey of Recent Developments in Mechanized Coal Mining," was read by Mr. G. R. Buchanan, of The Fife Coal Company. The paper dealt particularly with what had been done and was being done in the Company's collieries and attracted many members from the shale fields, who made up a large proportion of the attendance of over 100.

A vote of thanks to the lecturer was proposed by Mr. John M. Caldwell and to the chairman by Prof. W. M. Cumming.

The Branch Committee is indebted to Dr. William Reid, a member of the Committee, General Manager of The Fife Coal Co. Ltd., and recently appointed Production Director of the Coal Board in Scotland, for arranging the meeting.

---

## STANLOW BRANCH.

The Stanlow Branch of the Institute held its first meeting of the current session on October 16, when the following films were shown :

"*Through the Mills.*" (Stewarts & Lloyds, Ltd.) This illustrated the manufacture of steel tubes.

"*An English Oilfield.*" Depicting developments at Eakring.

"*Production of High Quality Steel.*" (Hadfields, Ltd.). Questions on the subject of this film were answered by Mr. W. H. Salmon, of Hadfields, Ltd.

---

## APPLICATIONS FOR MEMBERSHIP OR TRANSFER.

The following have applied for admission or transfer to the Institute. In accordance with the By-laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

### *Applications for Membership.*

BOWKETT, Terence John, Student, Royal School of Mines. (*S. E. Coomber; G. D. Hobson.*)

CLARKE, Arthur Henry, Senior Chemist, Geochemical Laboratories. (*H. B. Milner; L. J. Chalk.*)

COOKE, Percy Frederick, Research Chemist, "Shell" Central Laboratories. (*W. R. P. Hodgson; J. Parrish.*)

GADSBY, Gordon Neville, Principal Lecturer, Applied Chemistry Branch, Military College of Science. (*J. R. H. Whiston; J. B. Robinson.*)

GREENWAY, John Henry, Installation Supervisor, Petroleum Board. (*A. H. Stephenson; J. Parrish.*)

HANIFF, Mohamed, Junior Engineers' Assistant, Lago Oil & Transport Co. Ltd., Aruba.

JENNER, Peter, Chemical Assistant, "Shell" Refining & Marketing Co. Ltd. (*W. R. P. Hodgson; P. G. Higgs.*)

LARSON, Clifford M., Chief Consulting Engineer, Sinclair Refining Co., New York. (*A. E. Miller; K. G. Mackenzie.*)

MCFADYEN, Robert William, Assistant to Sales Manager, Lobitos Oilfields Ltd. (*J. S. Parker; D. M. Glendinning.*)

MCGUINNESS, Thomas Frederick, Mechanical Engineer, Texas Oil Co. Ltd. (*H. Weiser; W. H. Goodhind.*)

OSWALD, Roman Kazimierz, Member of the Institute of Technical Research, General Staff, Polish Army. (*S. Sulimirski; A. L. Wachal.*)

PAYNE, Henry Fernie, Secretary, Liverpool Storage Co. Ltd. (*T. A Hallam; H. Grosvenor.*)

POTTER, Kenneth, Sales Engineer, The Texas Oil Co. Ltd. (*H. Weiser; W. H. Goodhind.*)

SMITH, Barry Dudley, Petroleum Laboratory Technician, R.A.F. (*W. Johnson; G. C. McEwen.*)

WATSON, Bernard William James, Managing Chemist, Hampshire County Council. (*A. W. Attwooll; D. C. Broome.*)

WHITCHURCH, Ronald, Office Engineer, "Shell" Refining & Marketing Co. Ltd. (*E. LeQ. Herbert; P. M. Griffiths.*)

### *Applications for Student Membership.*

*(Proposed by F. H. Garner.)*

| | | | |
|---|---|---|---|
| CHARLES, Eric John, | Student, | University of | Birmingham. |
| EDGHILL, Charles Murray, | ,, | ,, | ,, |
| FORSTER, Archibald William, | ,, | ,, | ,, |
| FOSBURY, David William, | ,, | ,, | ,, |
| GRAFTON, Raymond William, | ,, | ,, | ,, |
| HAMMERTON, Denis, | ,, | ,, | ,, |
| HINDE, Peter, | ,, | ,, | ,, |
| HIXON, Fred Ernest, | ,, | ,, | ,, |
| HORNIBROOK, John Nevill, | ,, | ,, | ,, |
| LINDNER, James Neville Donovan, | ,, | ,, | ,, |
| MORRIS, Dennis Michael, | ,, | ,, | ,, |
| WEBB, Charles Gerald, | ,, | ,, | ,, |

### *Transfer.*

ANDREWS, Basil George, Field Chemist, Caribbean Petroleum Co. Ltd. Venezuela. (*W. R. P. Hodgson ; J. Parrish.*) (*Student to Associate Member.*)

BARBER, Bernard Thomas, Trainee Exploitation Engineer, Anglo-Saxon Petroleum Co. Ltd. (*F. H. Garner ; A. H. Nissan.*) (*Student to Associate Member.*)

MARTYN, John Robert, Geologist, British Controlled Oilfields, Ltd., Ecuador. (*Student to Associate Member.*)

MIMA, Heshmat, Maintenance Engineer, Anglo-Iranian Oil Co. Ltd., Tehran. (*Student to Member.*)

PALMER, Edward Reginald, Senior Scientific Officer, Ministry of Supply. (*W. H. Thomas ; A. R. Ogston.*) (*Student to Fellow.*)

STARK, Allan Ramsay, Chemist, Anglo-Iranian Oil Co. Ltd. (*G. H. Coxon ; F. E. Smith.*) (*Associate Member to Fellow.*)

WRIGHT, William Roy, Chemical Department, Shell-Mex & B.P. Ltd. (*F. N. Harrap ; C. Chilvers.*) (*Student to Member.*)

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## PERSONAL NOTES.

The Council of the Royal Society of Arts has awarded Silver Medals for the Session 1945–46 for "works of high merit and national value" to the following for the papers referred to :

Major W. H. Cadman, M.B.E., F.Inst.Pet., "Colloidal Carbon."

Percy Evans, M.A., M.Inst.Pet., "The Oilfields of India and Burma."

A. Clifford Hartley, C.B.E., F.Inst.Pet., "Operation Pluto."

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## RETIREMENT OF MR. F. C. STARLING.

Mr. F. C. Starling, who retired at the end of September last from his post as Under-Secretary in charge of the Petroleum Division

of the Ministry of Fuel and Power, first became associated with the petroleum industry in 1929, when the then Petroleum Department was transferred from the Board of Trade to the Mines Department. He was appointed Director of the Department in 1931 and for several years was also in charge of the Fuel Treatment Branch of the Mines Department.

In 1934 he was promoted to Assistant Secretary and it was in that year that the Hydrocarbon Oils Production Act, which led to the building of the hydrogenation plant at Billingham, and the Petroleum (Production) Act, which sought to promote the wider search for petroleum in Great Britain, were passed.

When the Falmouth Committee was set up in 1937 to investigate the question of oil from coal with particular reference to Britain's needs for oil supplies under emergency conditions, Mr. Starling was appointed a Joint Secretary. He was also a member of a Sub-Committee of the Oil Board investigating British Empire oil supplies, and of a Technical Sub-Committee examining storage questions.

During 1938 and 1939 Mr. Starling was closely associated with the preparation of emergency schemes should war materialize, and in 1941 was made Director of Petroleum Supplies, a post which he retained for the remainder of the war. For his work as Director of the Petroleum Department he was awarded the C.B.E. in January 1939.

When the United States entered the war, Mr. Starling became intimately concerned with the British and American organizations set up to ensure that the greatly expanded needs for petroleum products for the war effort were maintained. This was a major war problem and involved him in several visits to the U.S.A. and in many discussions with American representatives who visited Britain. His work in this connexion was recently recognized by the U.S. Government in the award of the Medal of Freedom with Silver Palm, generous tribute being paid to his efforts in the official citation.

During the war Mr. Starling was a member of the Oil Control Board, the committee of the War Cabinet responsible for oil policy, of its Executive Committee, and of the Tanker Advisory Committee appointed by the Minister of War Transport. In 1944 he was a member of the mission to Washington to explore at official level proposals for an Anglo-American Oil Agreement. He also accompanied the Ministerial Delegation headed by Lord Beaverbook in July of that year and, in September 1945, took part in the negotiations with the U.S. Delegation to Britain led by Mr. Harold Ickes which resulted in an Agreement being signed on behalf of both Governments.

An Honorary Member of the Institute, Mr. Starling served on the Executive Committee of the First World Petroleum Congress and was a member of the British Delegation to the Second World Petroleum Congress in Paris in 1937.

## REPORTS ON GERMAN INDUSTRY.
## B.I.O.S. INFORMATION SERVICE.

Although the B.I.O.S., C.I.O.S., F.I.A.T., and J.I.O.A. Reports on German Industry are available, either by purchase from H.M. Stationery Office or by reference in the principal public libraries, it is recognized that many firms have not the research staff available to examine the whole range relating to a particular industry or subject. Already nearly 1400 reports have been published and that number may well be doubled.

An Information Section has therefore been set up to deal with scientific enquiries arising out of these reports and will also have access to much additional information and documents not suitable for reproduction in publications.

It is important that prompt use be made of these facilities if the full value of the intelligence available is to be realized and enquiries should be addressed to B.I.O.S Information Section, 37, Bryanston Square, London, W.1.

An exhibition illustrating the methods of gathering the information on German wartime developments was held in London during December and will be repeated in Bristol, Cardiff, Birmingham, Manchester, Nottingham, Leeds, Newcastle, Glasgow, and Belfast.

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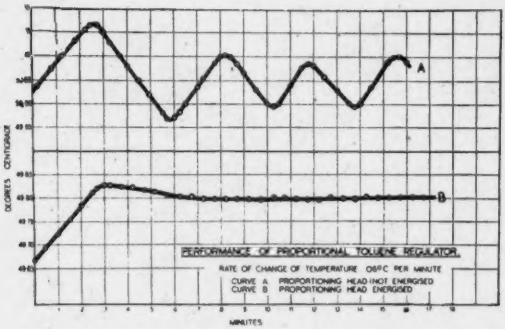


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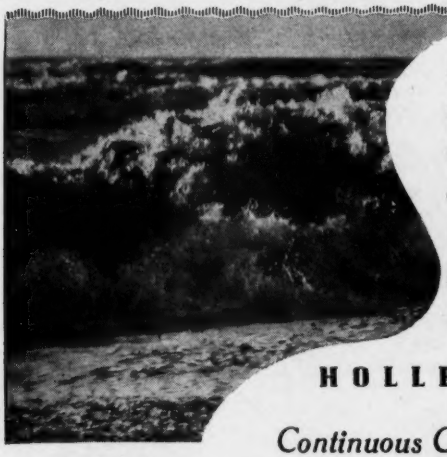

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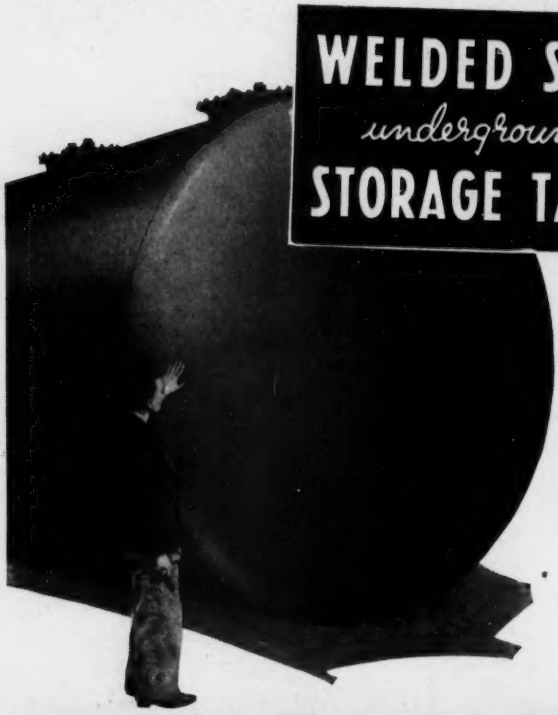

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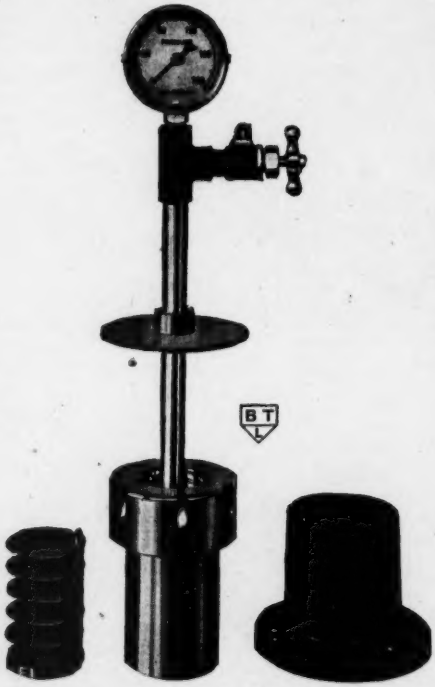

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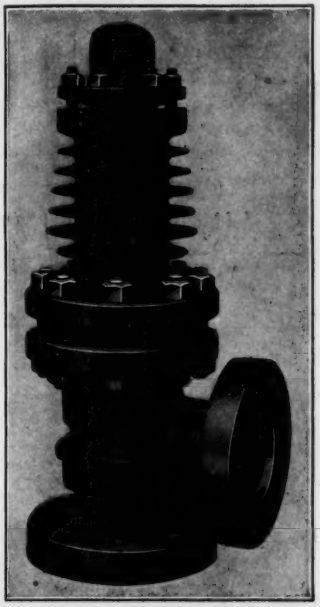

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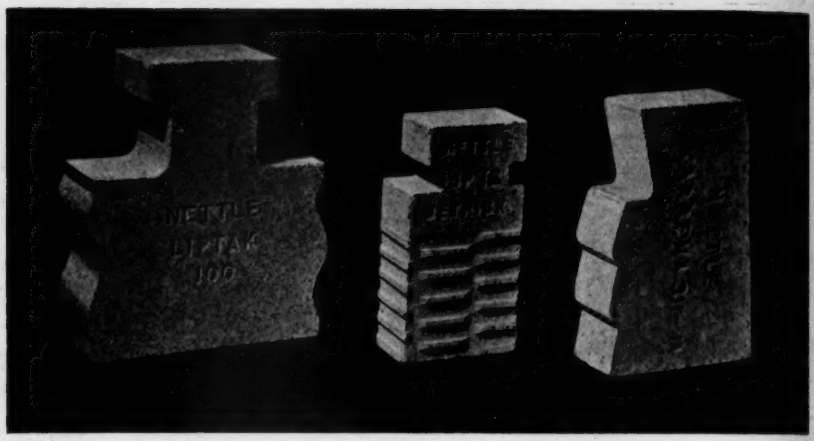

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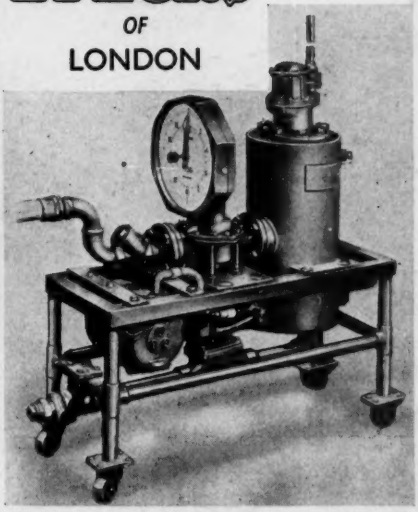

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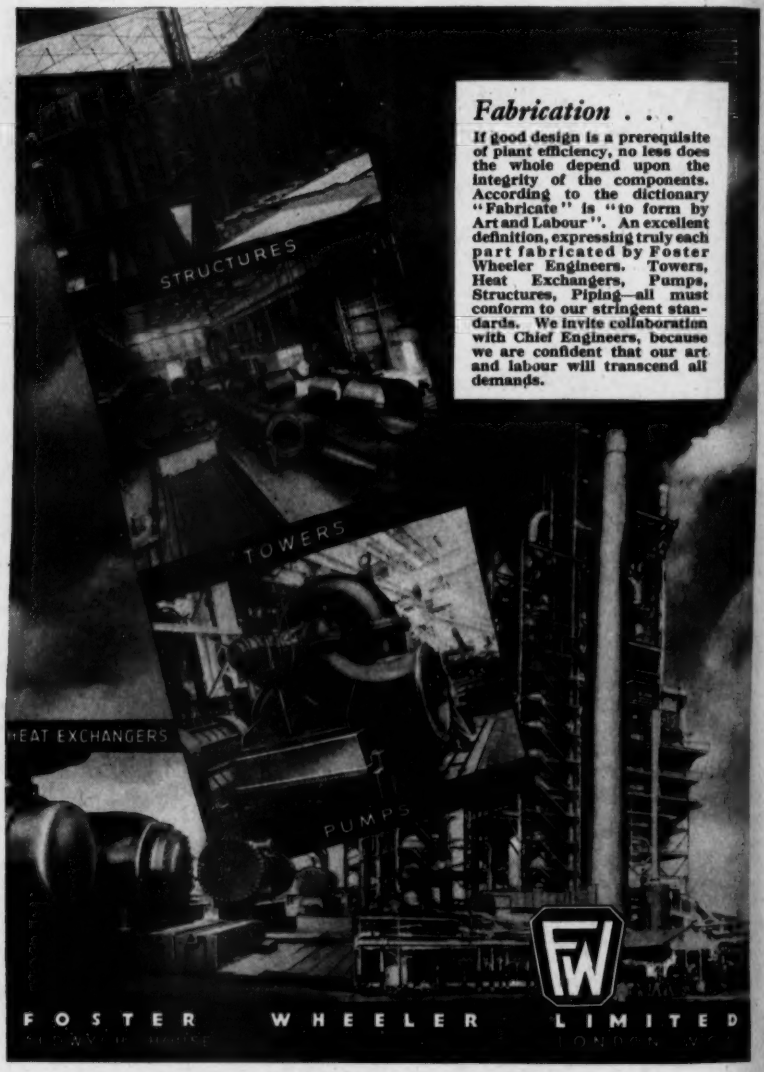


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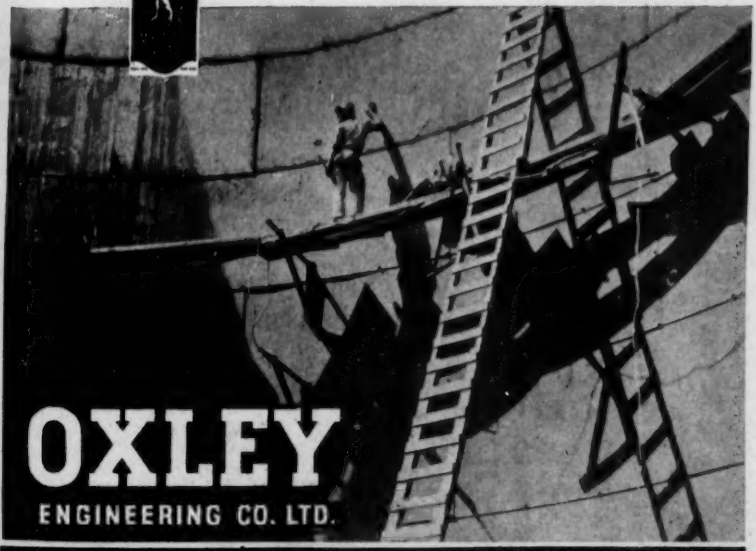

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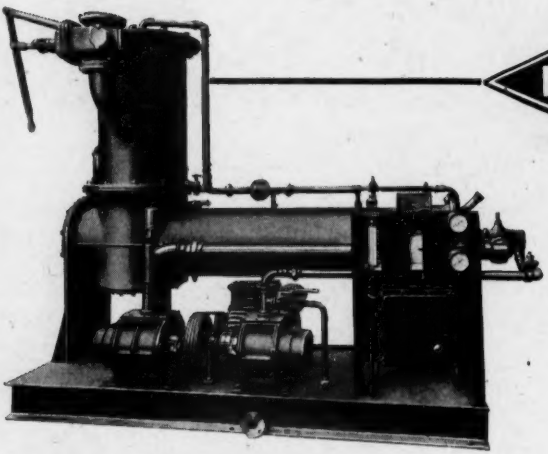

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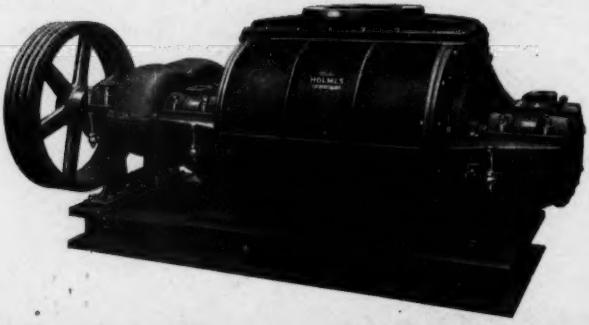

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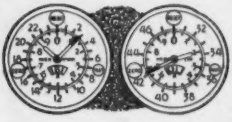

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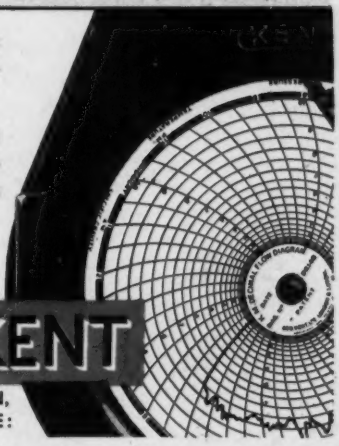

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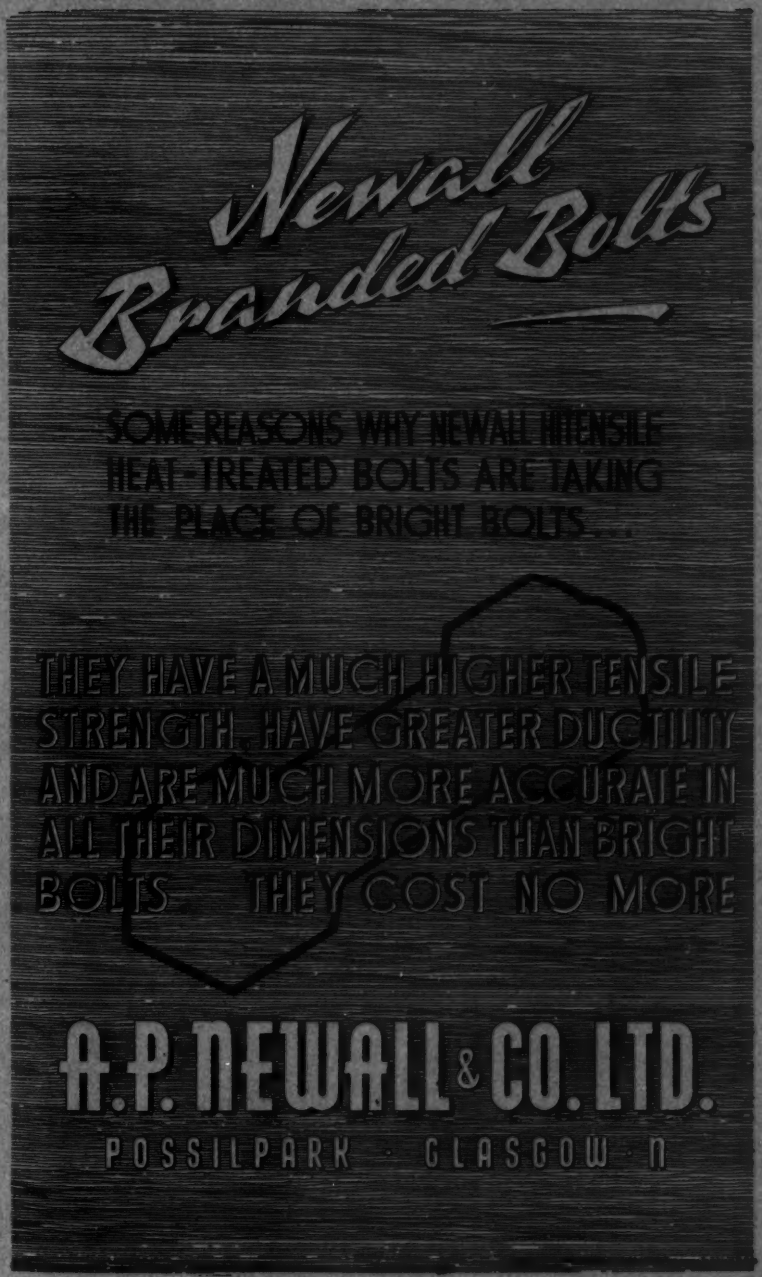
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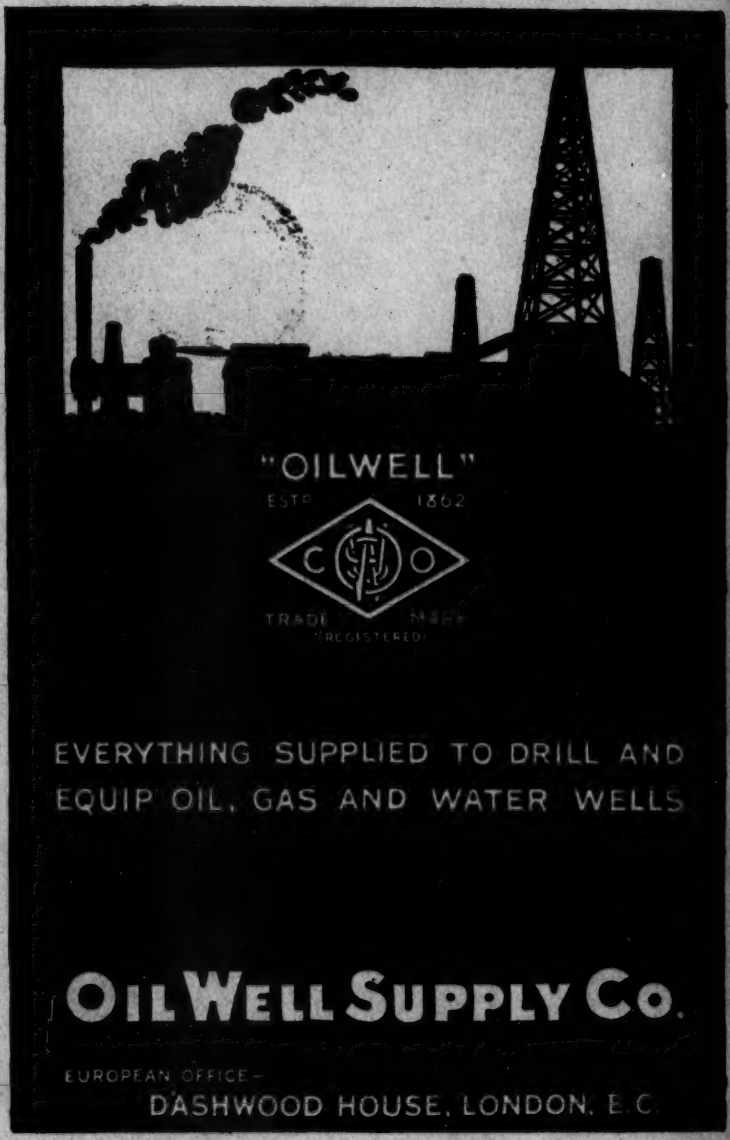


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